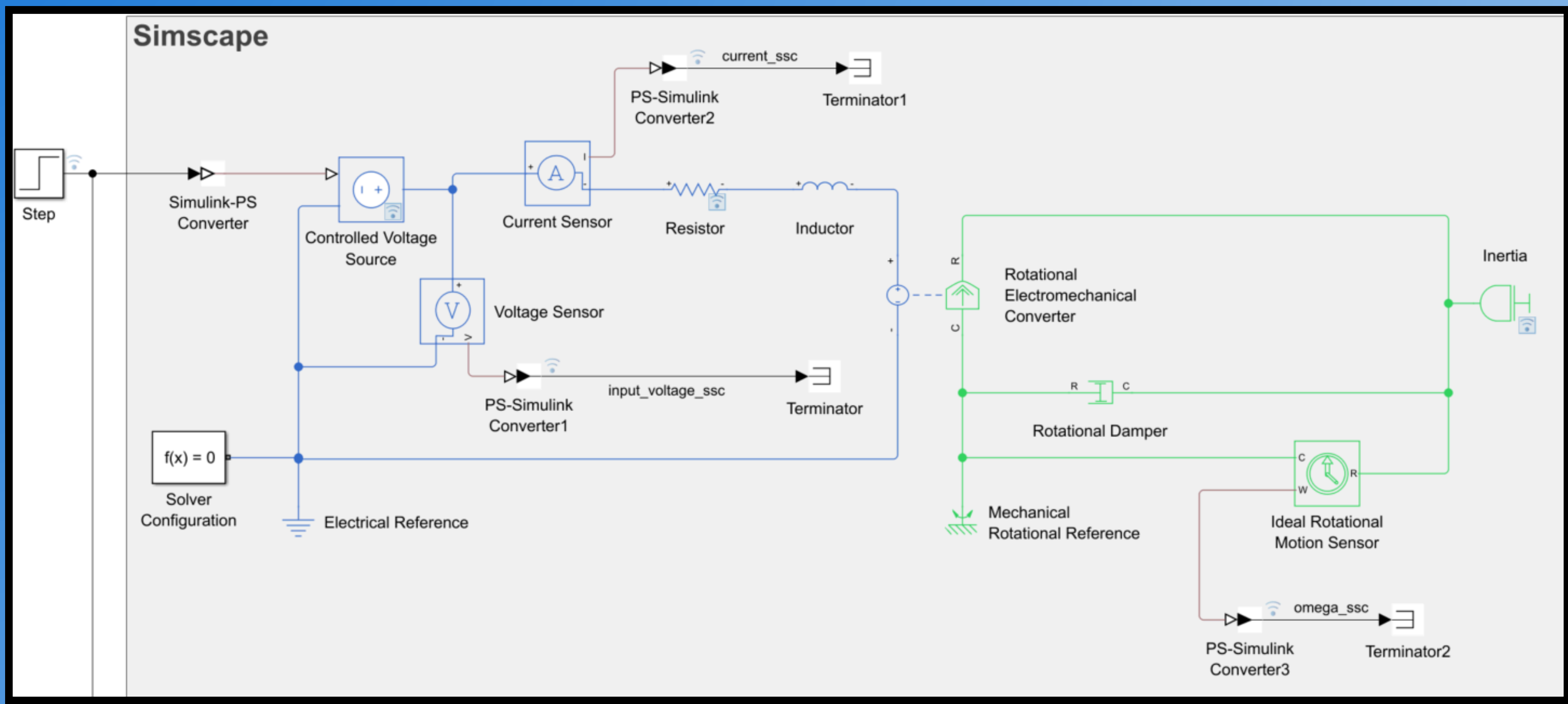
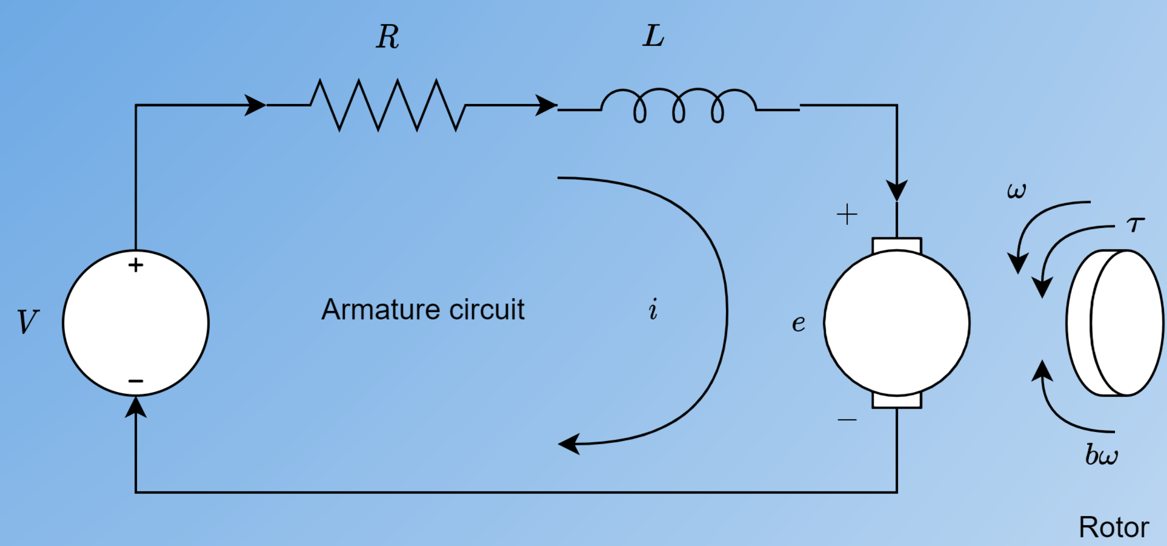
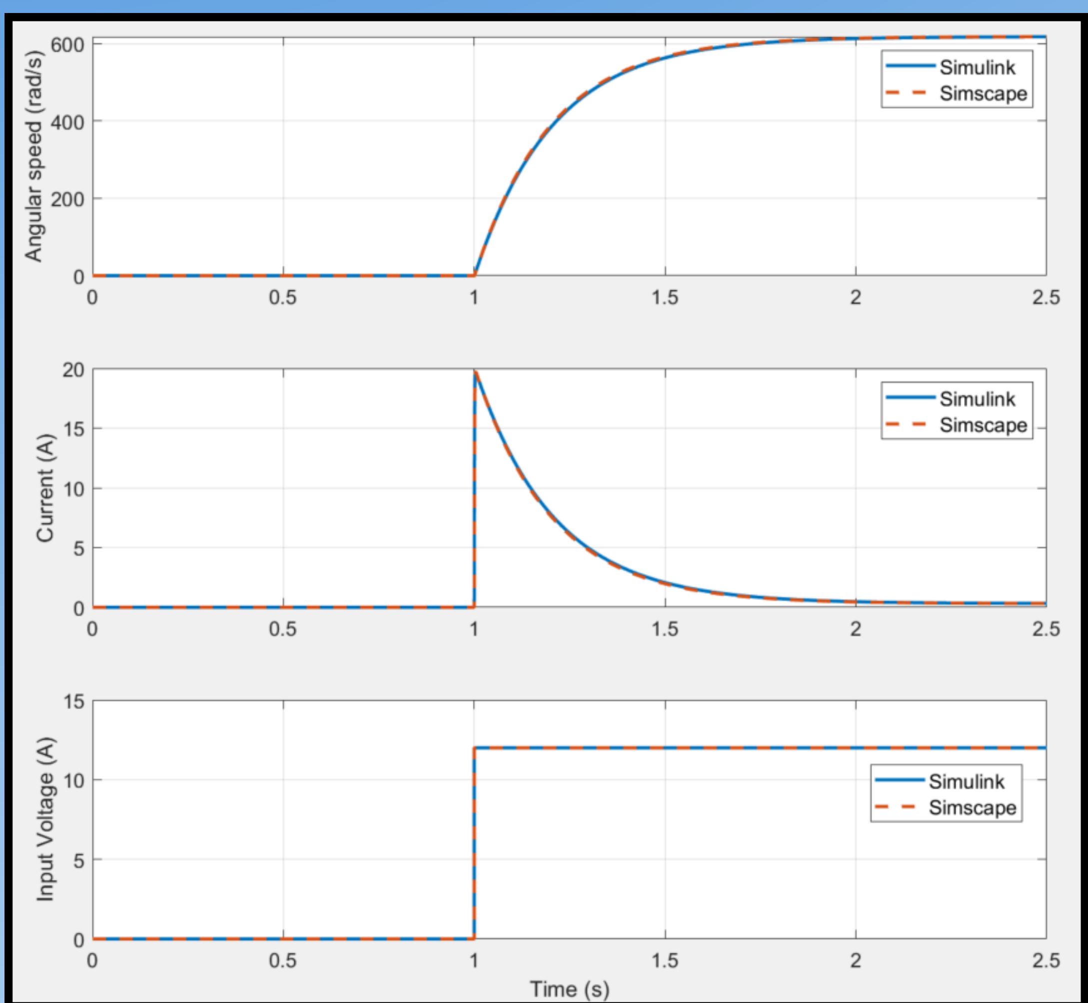
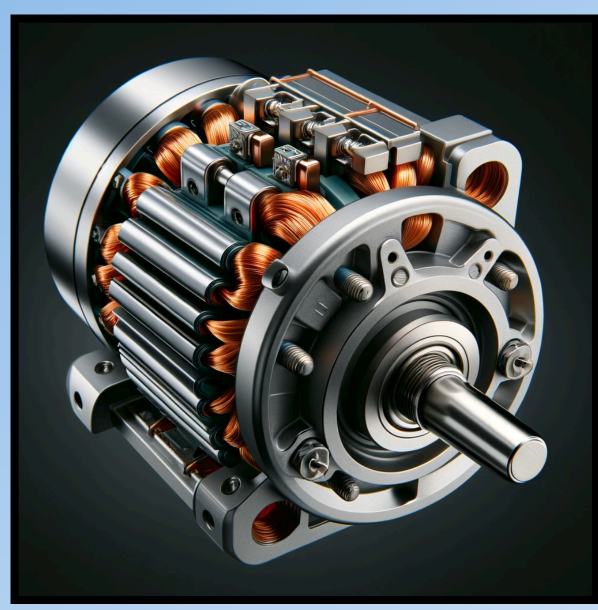
DC Motor Model
Simulink vs Simscape







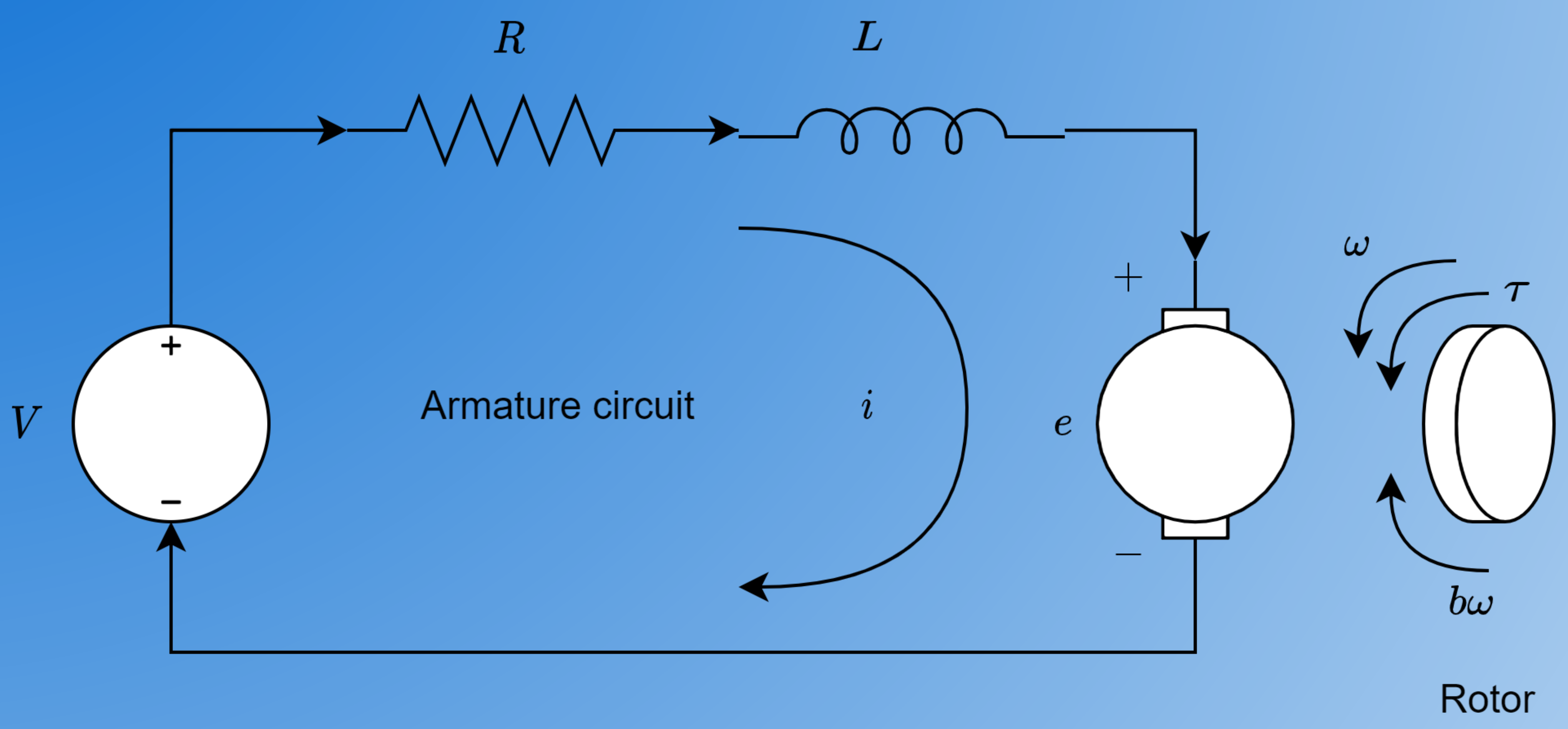


Model

https://github.com/simorxb/dc-motor-simscape

SIMONE BERTONI CONTROL LAB

DC Motor – Model



Mechanical - Newton's second law for rotational motion:

$$J\dot{\omega} + b\omega = \tau, \ \tau = k_t i$$

Electrical:

$$L\frac{di}{dt} + Ri = V - k_e\omega$$

Isolate the highest level derivatives to facilitate modelling:

$$\dot{\omega} = \frac{k_t i - b\omega}{J}$$

$$\frac{di}{dt} = \frac{V - k_e\omega - Ri}{L}$$

DC Motor – Parameters

Referring to the datasheet of a real DC motor (C23-L33-W10) from Moog (https://www.moog.com/content/dam/moog/literature/MCG/moc23series.pdf) we can derive our parameters:

Torque sensitivity (k_t) = 0.0187 Nm/A

Back EMF (k_e) = 0.0191 V/(rad/s)

Terminal resistance (R) = 0.6 Ohm

Terminal inductance (L) = 35 mH = 0.035 H

Damping factor (b) = 0.001 Nm/KRPM = 0.0000095 Nm/(rad/s)

Assuming that we are spinning a disc of radius 5 cm and mass 0.1 kg, we have:

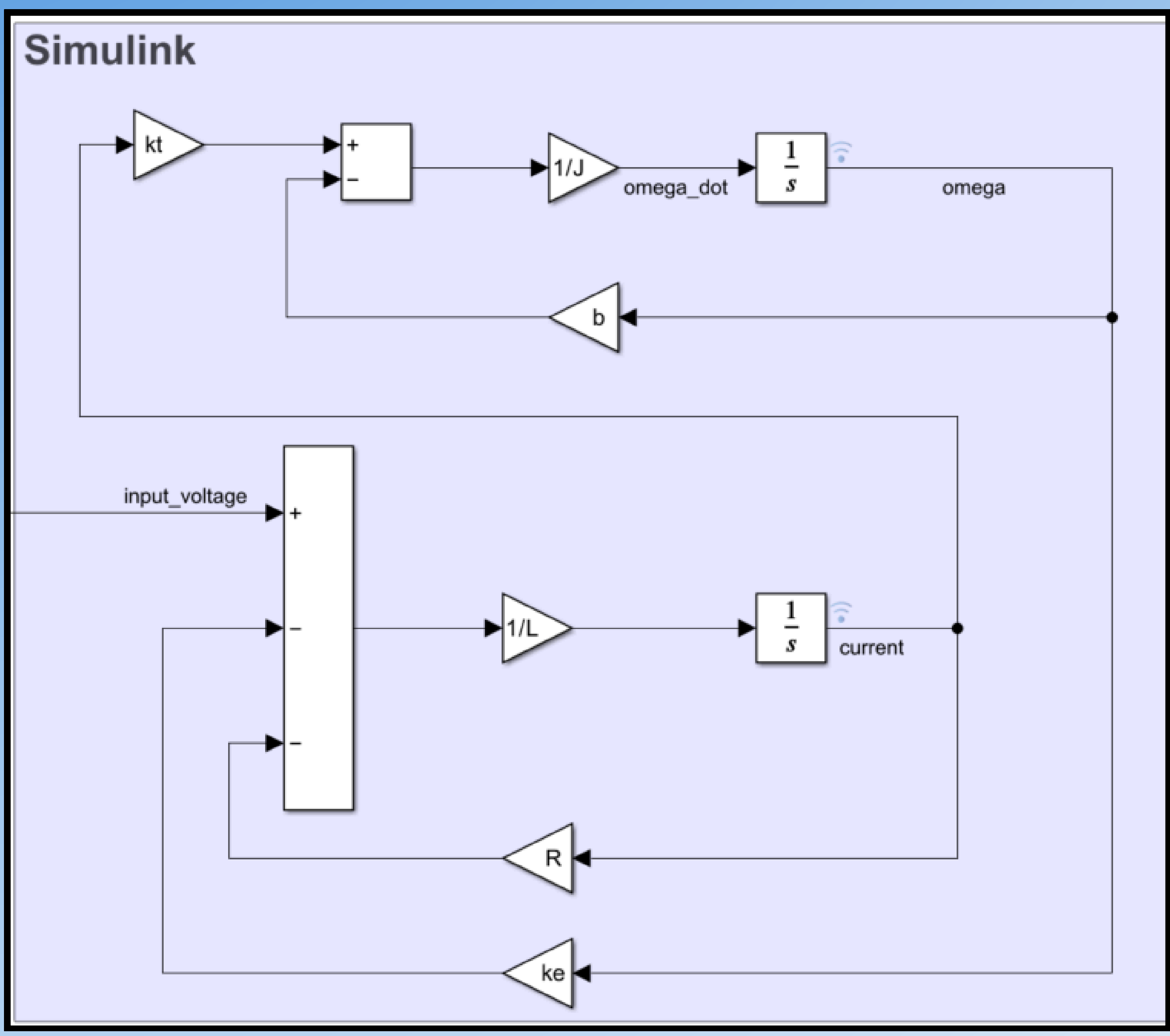
$J = 0.5mr^2 = 0.000125\ kgm^2$

Simulink Model

To build a Simulink model, you need to know the fundamental equations that govern how the system behaves:

- Motion
- Electricity
- Thermo-fluid dynamics
- Etc

Here's our DC Motor:

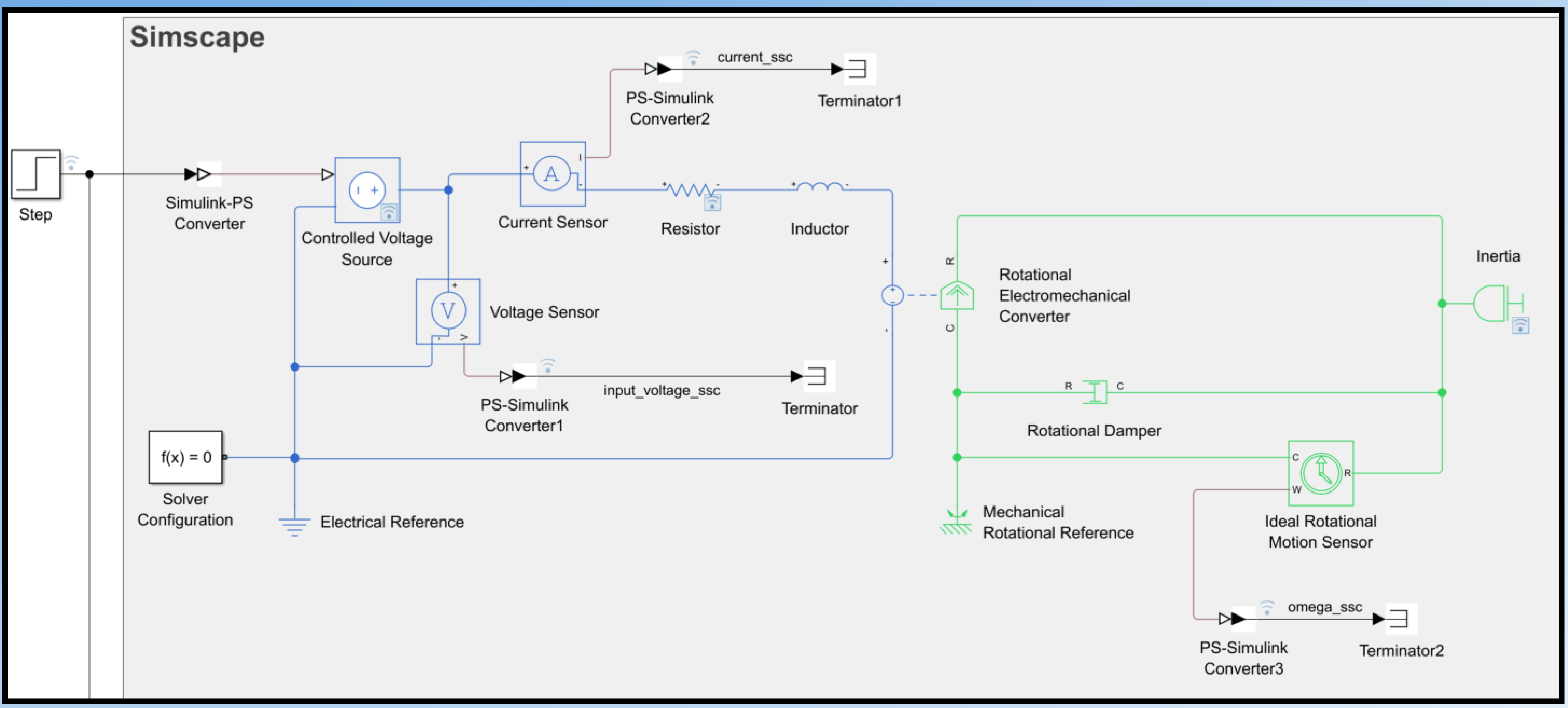


Simscape Model

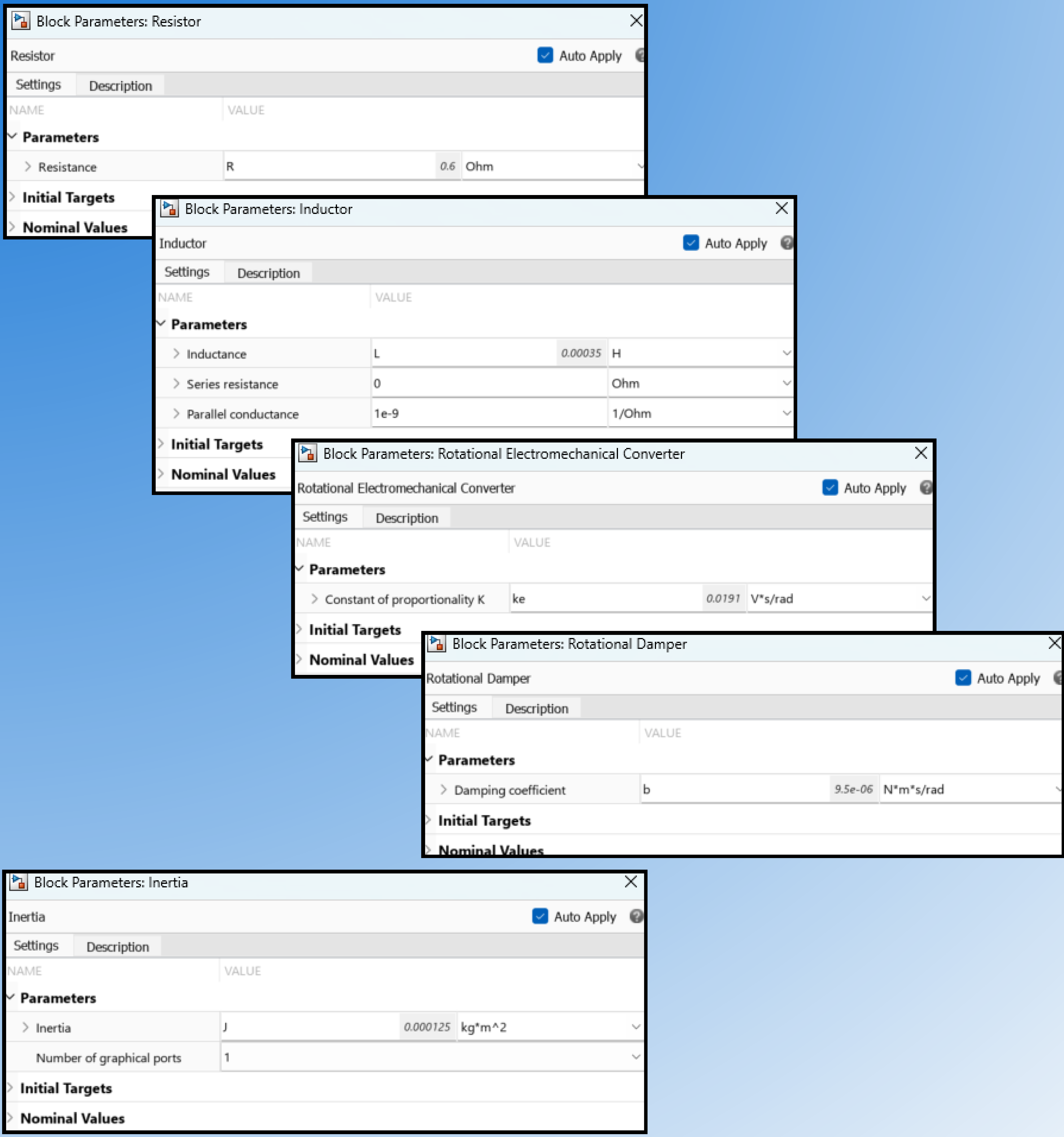
To build a Simscape model, you assemble fundamental components into a schematic that physically represents the system:

- Resistors, Inductors, Capacitors
- Dampers, Inertias
- Torque and force sources
- Pipes
- Sensors
- Etc

Here’s our DC Motor (it clearly resembles the physical schematic):



Simscape Model Configuration



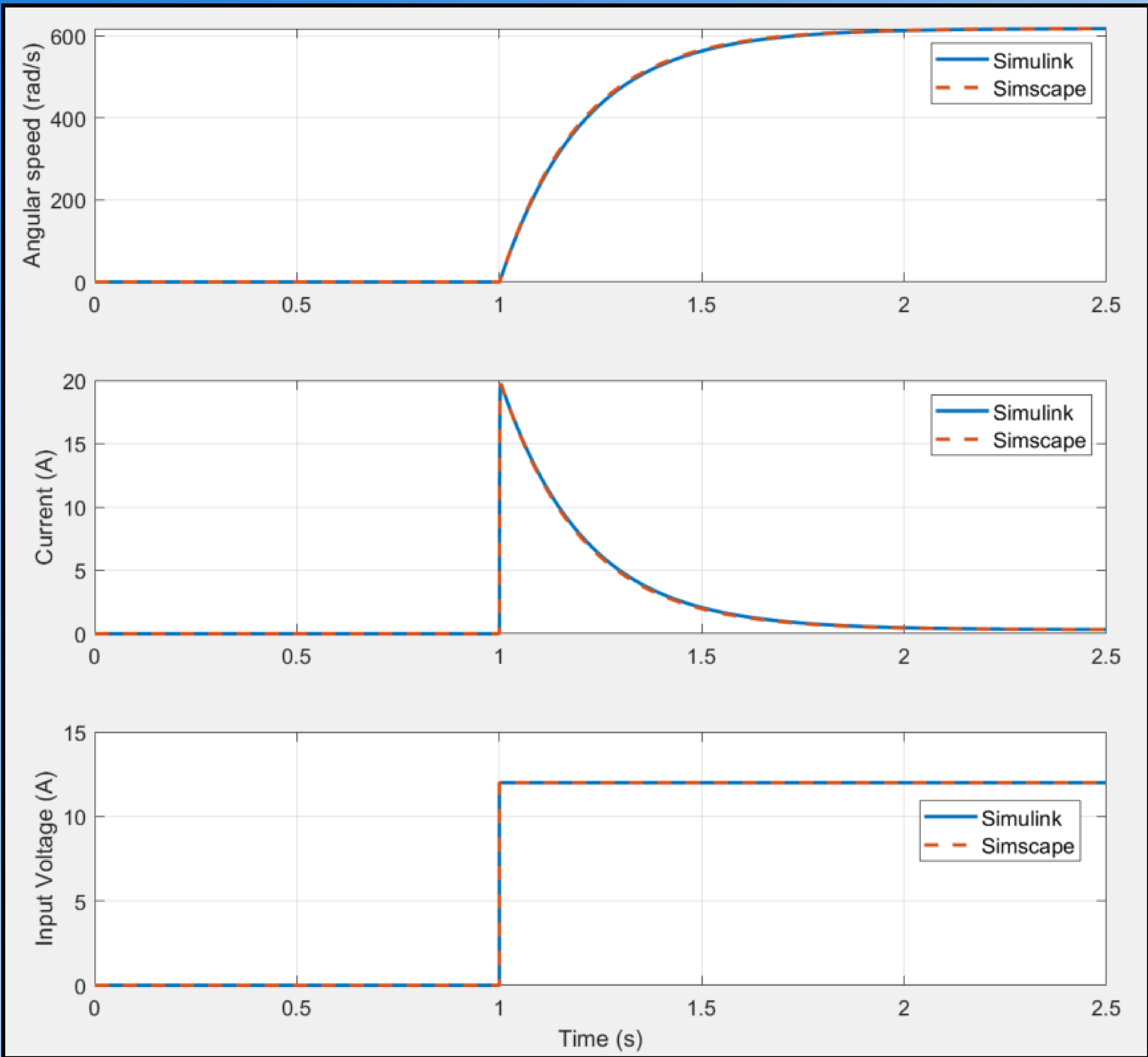
Simulation

The following slide shows the response of the two models to the same voltage step (12V) after 1 second of simulation.

As expected, the behaviour is the same.

We have modelled the same system using two completely different approaches.

Result


600
400
200
0
Angular speed (rad/s)
0
0.5
1
1.5
2
2.5
Simulink
Simscape
20
15
10
5
0
Current (A)
0
0.5
1
1.5
2
2.5
Simulink
Simscape
15
10
5
0
Input Voltage (A)
0
0.5
1
1.5
2
2.5
Time (s)
Simulink
Simscape

PID Controller Course

https://simonebertonilab.com

Understand the control theory

April 28, 2024

I think the most important thing is to understand the meaning behind the mathematical formula. I guess this is the mission of Simone in this course and from my point of view he fully achivied this target. I hope to see in the future other courses (e.g advanced controls) structered in the same way with the same passion and examples.

Thank you Simone. Show less

Emidio Verified

Very helpful and practical

Yoav Golan

I enjoyed this course very much. I learned a lot of practical knowledge in a short time. Simone is very clear and teaches well, thank you! In the future, I would be very interested if Simone added a course with more subjects, such as cascading controllers, rate limiting, and how the controllers look in actual code. Thanks again!

Intuitive and Practical

Ranya Badawi

Simone's explanation of PID control was very intuitive. This is a great starter course to gain a fundamental understanding and some practical knowledge of PID controllers. I highly recommend it. For future topics, I'd be interested in frequency response, transfer functions, Bode plots (including phase/gain margin), Nyquist plots, and stability.

Very good sharing of experience

Romy Domingo Bompart Ballache

I have background in control system for power electronics, I see every lesson very useful.

Great course

April 15, 2024

Right to the point, easy to follow and very practical. I missed the zero/pole placement and phase margin analysis. It would also be interesting if you could provide other plants examples. Anyway, a great course to help designing and tuning a PID controller.

Leonardo Starling Verified

A different way to learn PID !

May 31, 2023

The teacher explains PID in a clear way adding his experience there where formulas alone cannot do much. Furthermore, each topic covered is included in a practical example to better fix ideas.

Michele De Palma