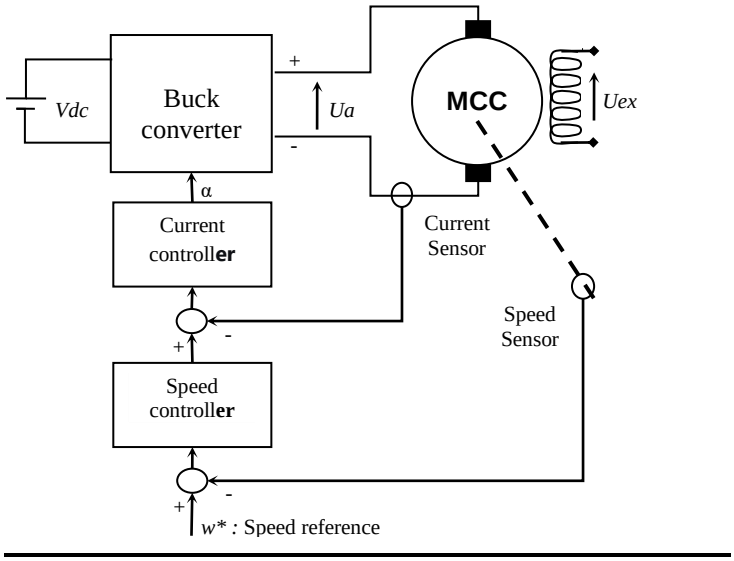
Electrical Engineering Departement
Licence: ELT–ELM- S6

LabN° 2

DC motor speed regulation

Objective
Analyze the performance of a DC motor (Speed, Current, Torque, etc.) in the case of speed control.

System Description
The complete diagram of the DC motor speed control system is shown in the following figure:



The motor is powered by a DC source via a series chopper consisting of a GTO thyristor and a freewheeling diode D1. The motor is subjected to a load torque Cr which may be variable.

The speed control system operates with two loops:

A closed loop ensuring speed regulation

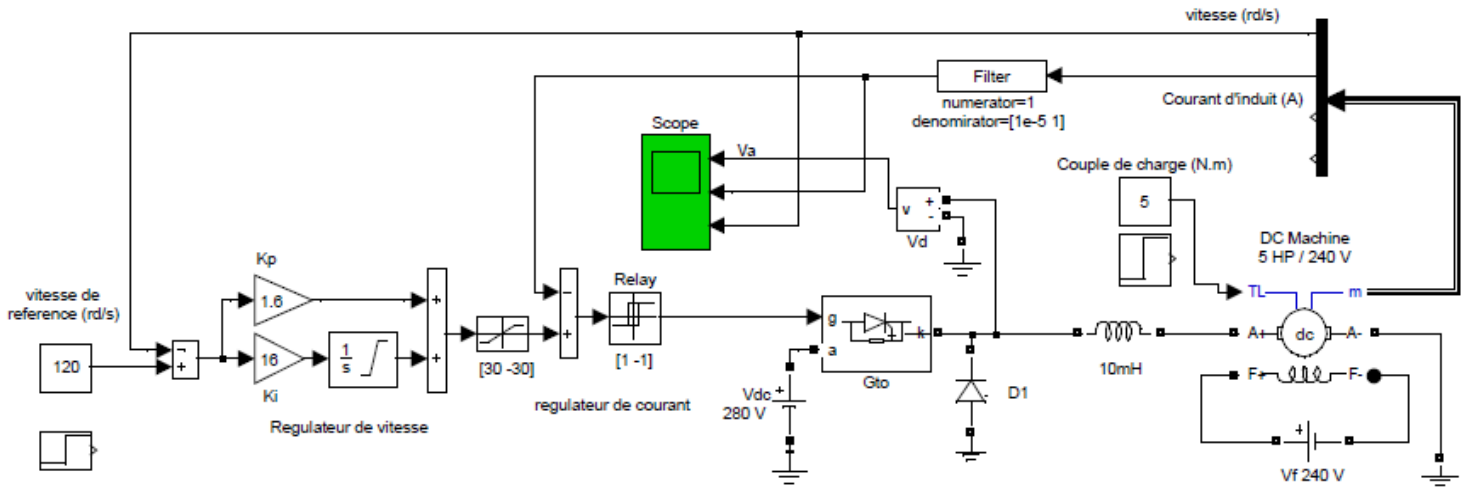
A closed loop ensuring current regulation

The speed controller is of PI type (Proportional-Integral) which generates the reference for the current loop. The current controller is of Hysteresis type; it compares the measured current with the reference and generates the gate signal α for the GTO thyristor to force the current to follow the reference.

Speed Control Simulation

Create the following virtual setup in SimPowerSystem.

The simulation will be performed on a 5HP (3.7KW) DC motor.



In the machine parameter settings:

- Armature winding parameters – Ra (Ω), La (H)*: [0.5 0.01]*
- Field winding parameters – Rf (Ω), Lf (H) *: [240 120]*
- Field-armature mutual inductance Laf (H)*: 1.23*
- Total inertia of the machine and load – J (kg·m²)*: 0.05*
- Viscous friction coefficient – Bm (N·m·s)*: 0.02*
- Dry friction coefficient – Tf (N·m)*: 0*
- Initial speed (rad/s)*: 0.1*

The speed PI controller parameters are: Kp = 1.6, Ki = 16. The output of this controller is connected to a saturation block to limit the current between 30A and -30A.

For the current controller, the hysteresis band is set to 2 (i.e., in the Relay block: switch on point = 1 and switch off point = -1).

1.1 Simulate the system operation for a reference speed of 120 rad/s and a constant load torque of 5 Nm;

1.2 Plot the motor current and voltage;

1.3 Plot the rotational speed and its reference on the same graph;

1.4 Explain the shape of these curves;

2.1. Repeat the simulation for a speed reference of 120 rad/s at startup and 160 rad/s from 0.4s, and apply a load torque of 5 Nm at startup and 25 Nm from 1.2s (use the STEP function);

2.2 Plot the motor current and voltage;

2.3 Plot the rotational speed and its reference on the same graph;

2.4 Explain the shape of these curves;

3. General conclusion.