

PW1: DC Motor Speed: System Modeling

Objective:

- Provide an approach to designing a simulation model using MATLAB-SIMULINK.
- Simulate the operation of a permanent magnet DC motor.
- Integrate simulation results into a report.

Designing a SIMULINK simulation model

We aim to simulate the behaviour of a DC motor. We define the process parameters, the names of the important variables, and the equations that describe its operation.

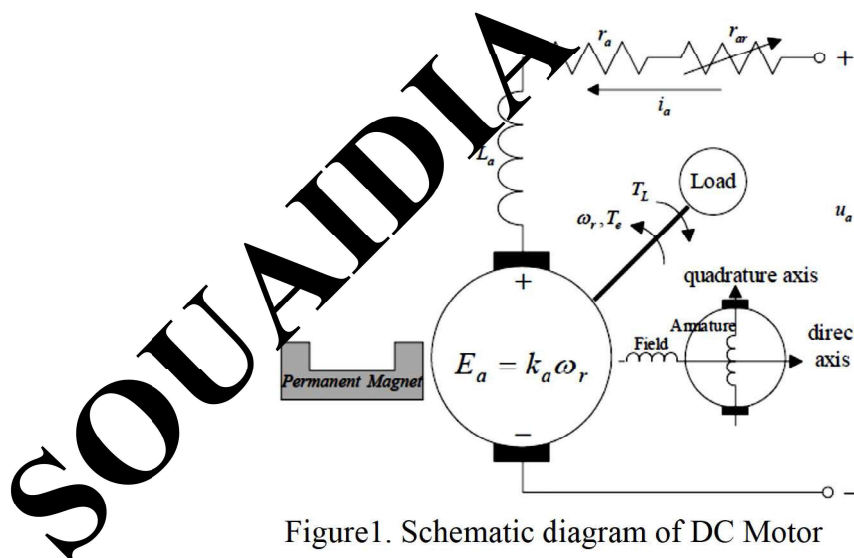


Figure1. Schematic diagram of DC Motor

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Applying Kirchhoff's law gives:

$$U_a = R_a I_a + L_a \frac{dI_a}{dt} + K_a \omega_r$$

The mechanical equation:

$$J \frac{d\omega_r}{dt} = T_e - T_L$$

The emf is: $E_a = K_a \omega_r$

The resistive torque is a function of friction and angular velocity: $T_r = B_m \omega_r$

The motor torque depends on the current developed in the armature: $T_e = K_a I_a$

Where L_a is the armature inductance, R_a is the armature resistance, K_a is the torque constant, J is the moment of inertia, B_m is the viscous friction, U_a is the induced voltage, I_a is the induced current, T_e is the motor torque, T_L is the resistive torque:

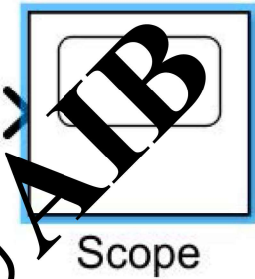
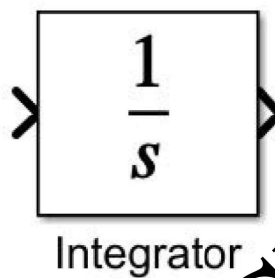
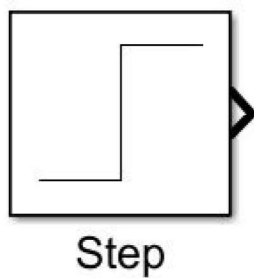
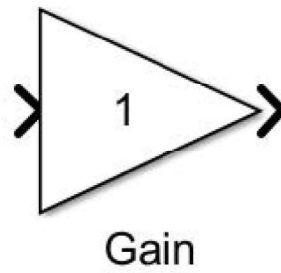
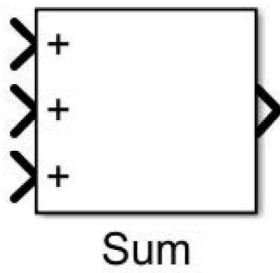
$$\frac{di_a}{dt} = -\frac{r_a}{L_a} i_a - \frac{k_a}{L_a} \omega_r + \frac{1}{L_a} u_a$$

$$\frac{d\omega_r}{dt} = \frac{k_a}{J} i_a - \frac{B_m}{J} \omega_r - \frac{1}{J} T_L$$

Note: the command and control variables: $x_1 = i_a$; $x_2 = \omega_r$ and $u = u_a$.

$r_a = 2.0$	% electric resistance	[Ohm]
$L_a = 0.5$	% electric inductance	[H]
$k_a = 0.015$	% electromotive force constant	[V/rad/sec]
$J = 0.02$	% moment of inertia of the rotor	[kg.m ²]
$B_m = 0.2$	% motor viscous friction constant	[N.m.s]
$V_a = 12$	% Power Supply	[V]
$T_L = 0.01$	% motor torque constant	[N.m/Amp]

Annexe:



Block Parameters: Step

Step

Output a step.

Main Signal Attributes

Step time:

1

Initial value:

0

Final value:

1

Sample time:

0

☒ Interpret vector parameters as 1-D

☒ Enable zero-crossing detection

?

OK Cancel Help Apply

Task To Do:

In the figure of the DC motor's speed from the scope block, draw these parameters (in the same figure):

- 1- Input signal (power supply).
- 2- Output signal (the speed of the DC motor).
- 3- Settling time.
- 4- Overshoot.
- 5- Steady-state error.
- 6- legend of each signal.

All of these parameters must be done programmatically.

SOUAIDIA CHOUAIB