Syrian Arab Republic
Distinction and Creativity Agency
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PMDC Mathematical Modelling

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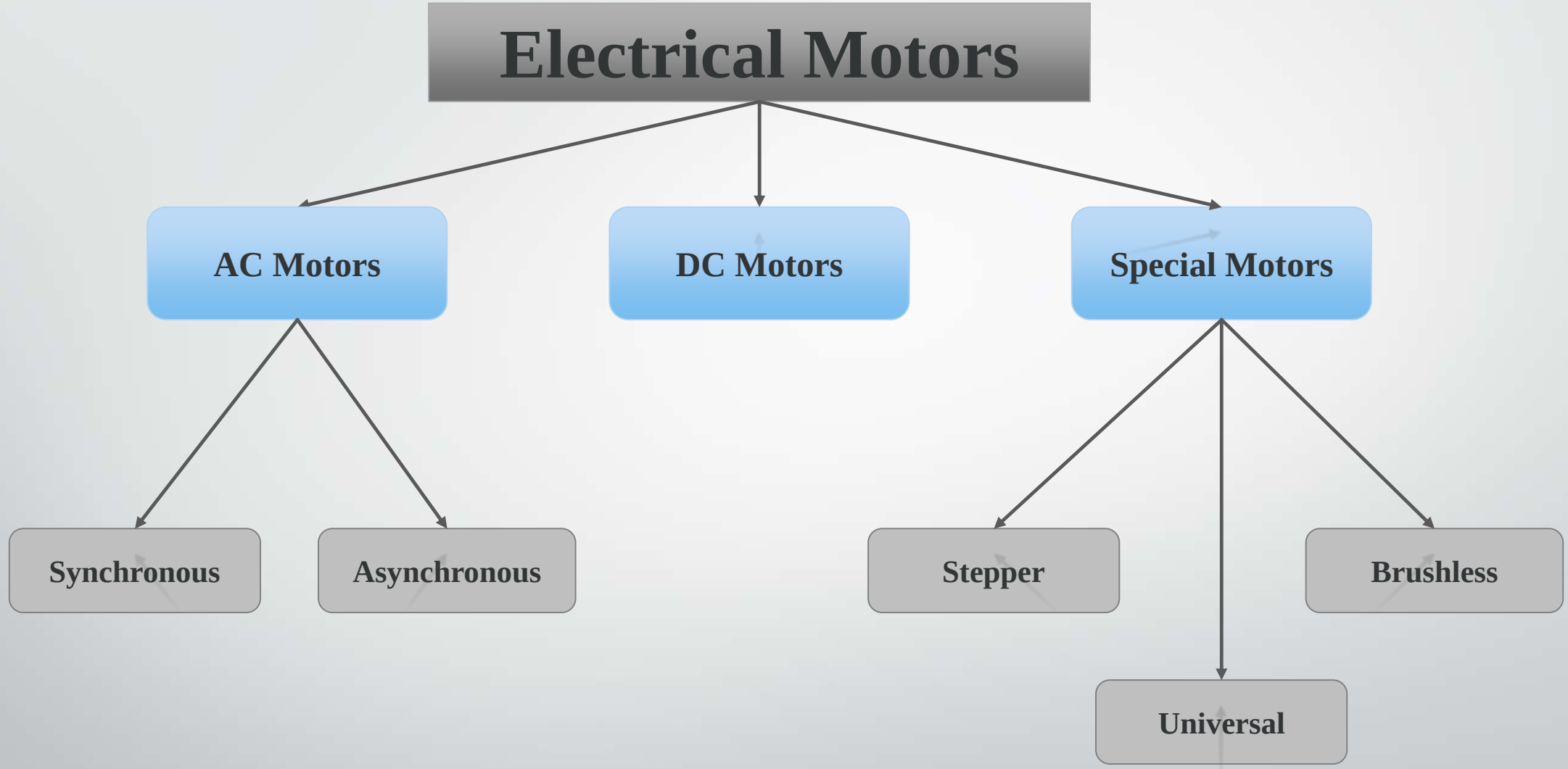
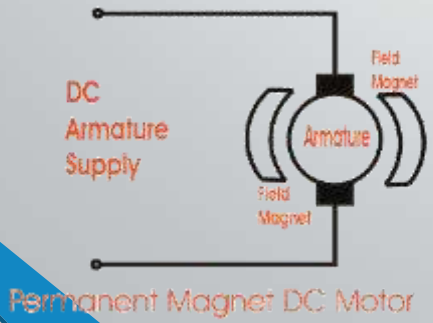
Introduction

- Electrical motors are widely used in many fields.
- They depend on the interaction between a current and a magnetic field.
- The first electrical motor was invented by Michael Faraday in 1821.
- Simulating a motor behavior will improve the quality of working and fasten it.

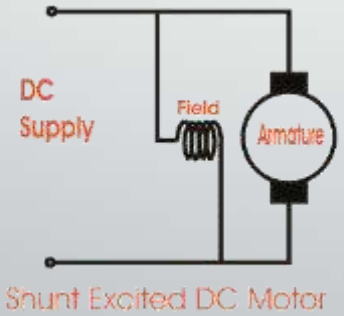

Electrical Motors
AC Motors
DC Motors
Special Motors
Synchronous
Asynchronous
Stepper
Brushless
Universal

Electrical Motors

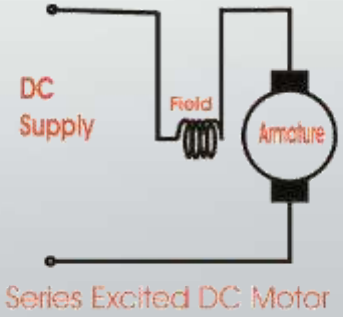
- AC Motors
- DC Motors
  - Permanent Magnet
  - Shunt
  - Series
  - Compound
  - Separately-Excited
- Special Motors



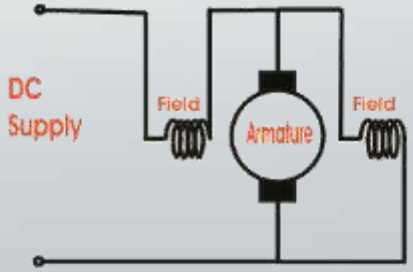
Permanent Magnet DC Motor



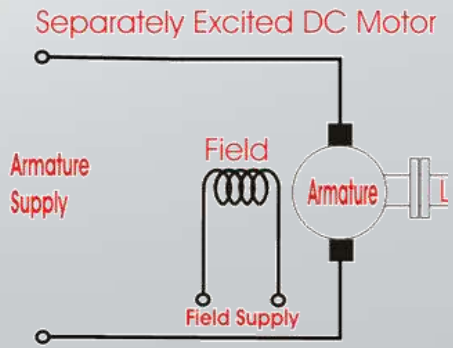
Shunt Excited DC Motor



Series Excited DC Motor



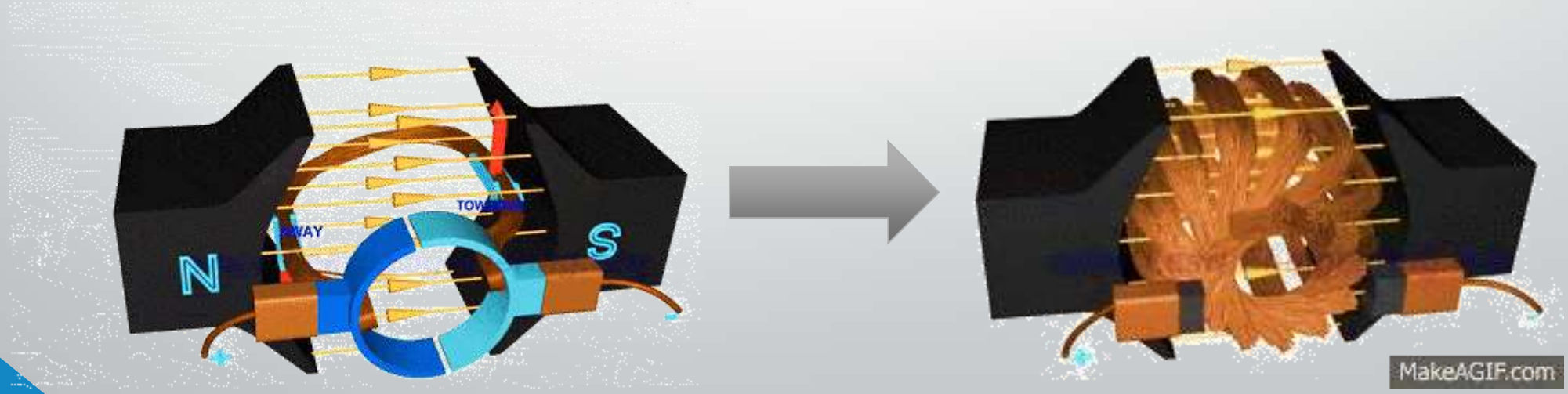
Cumulatively Compound Excited DC Motor



PMDC Motors

Permanent Magnet DC Motor

- The current flows in the windings of the rotor.
- The magnetic field is produced from a permanent magnet in the Stator.



Electrical Analysis

$$V_s = \sum V_{devices}$$

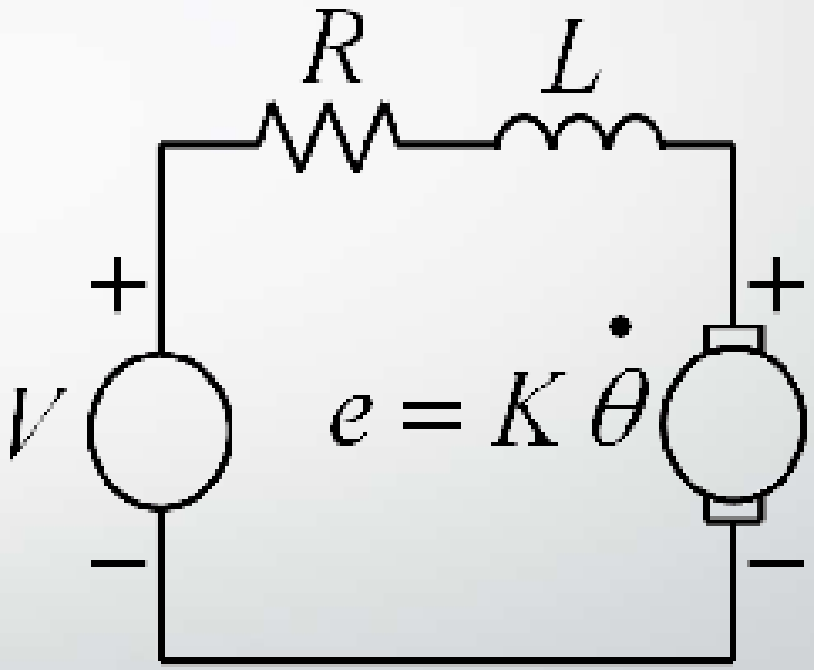
$$V_s = V_R + V_L - V_{emf}$$

$$V_s = L\frac{di}{dt} + Ri - Ke\dot{\theta}$$

$L = Armature\ Inductance$

$R = Armature\ Resistance$

$Ke = Back\ emf\ Constant$



Mechanical Analysis

$$J\ddot{\theta} = \sum \Gamma$$

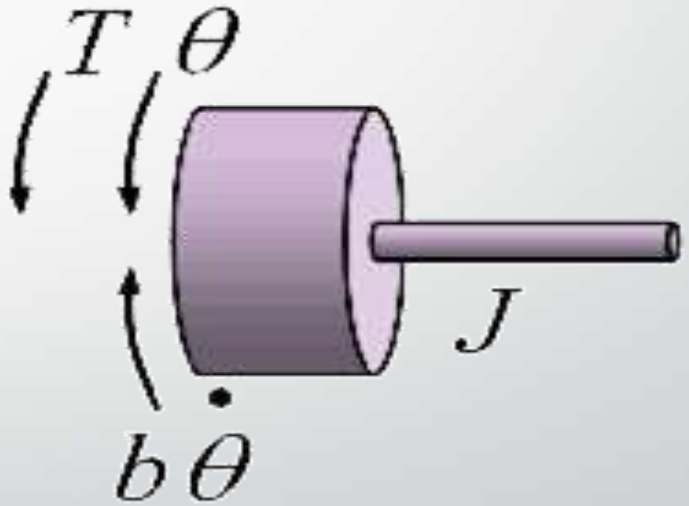
$$J\ddot{\theta} = T - \Gamma_{friction}$$

$$J\ddot{\theta} = Kt.i - b\dot{\theta}$$

$J = moment\ of\ inertia$

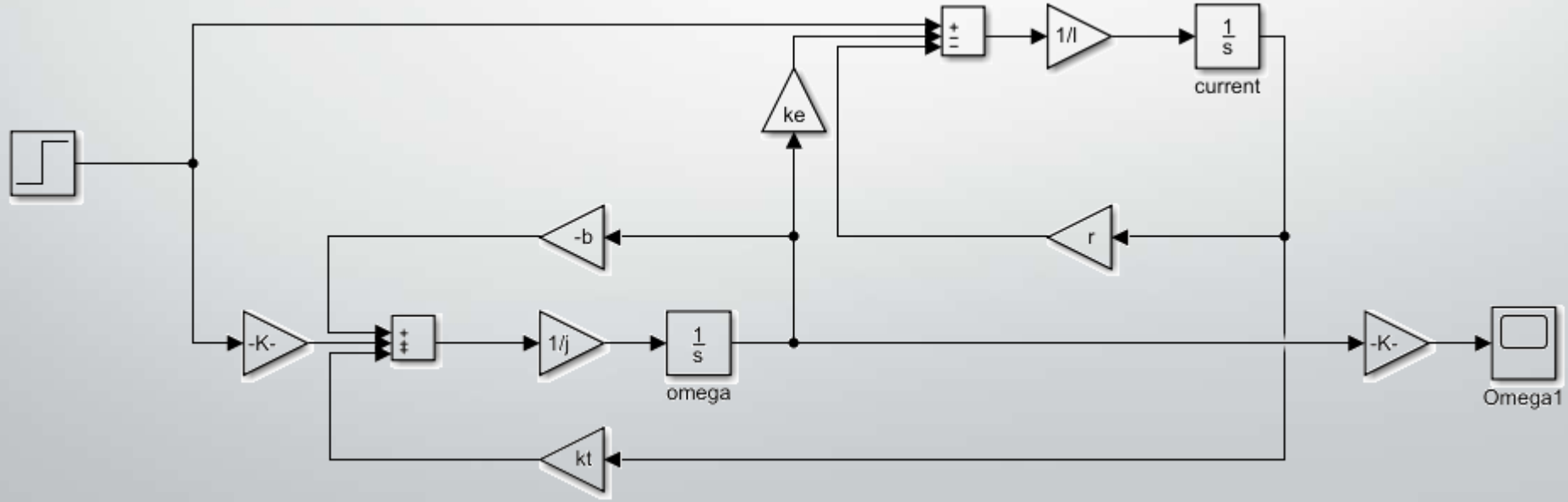
$b = friction\ constant$

$Kt = torque\ Constant$



Mathematical Modelling

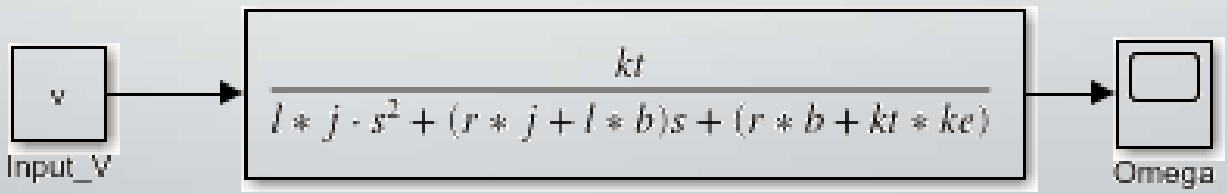
Simulink Charts



Mathematical Modelling

Transfer Function

$$\frac{\dot{\theta}(s)}{V(s)} = \frac{Kt}{Ke.Kt + (b + Js)(Ls + R)}$$



Mathematical Modelling

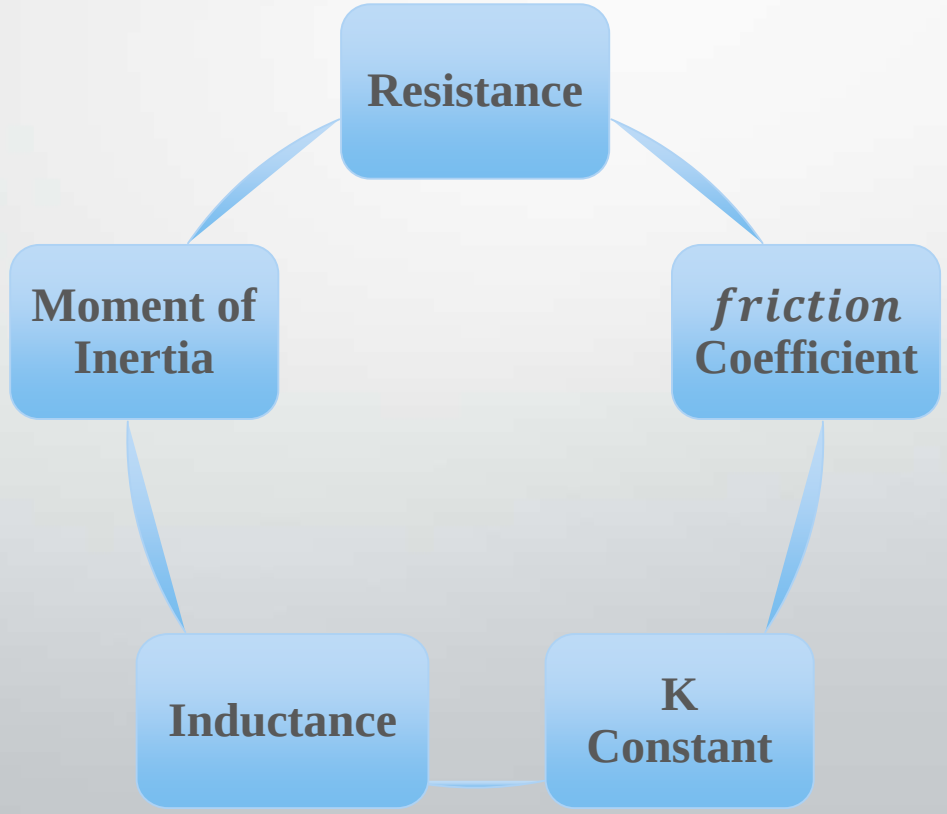
State Space Model

$$\begin{bmatrix} \dot{\theta} \\ i \end{bmatrix} = \begin{bmatrix} -\frac{b}{J} & \frac{Kt}{J} \\ -\frac{Ke}{L} & -\frac{R}{L} \end{bmatrix} \begin{bmatrix} \dot{\theta} \\ i \end{bmatrix} + \begin{bmatrix} 0 \\ 1/L \end{bmatrix} V$$

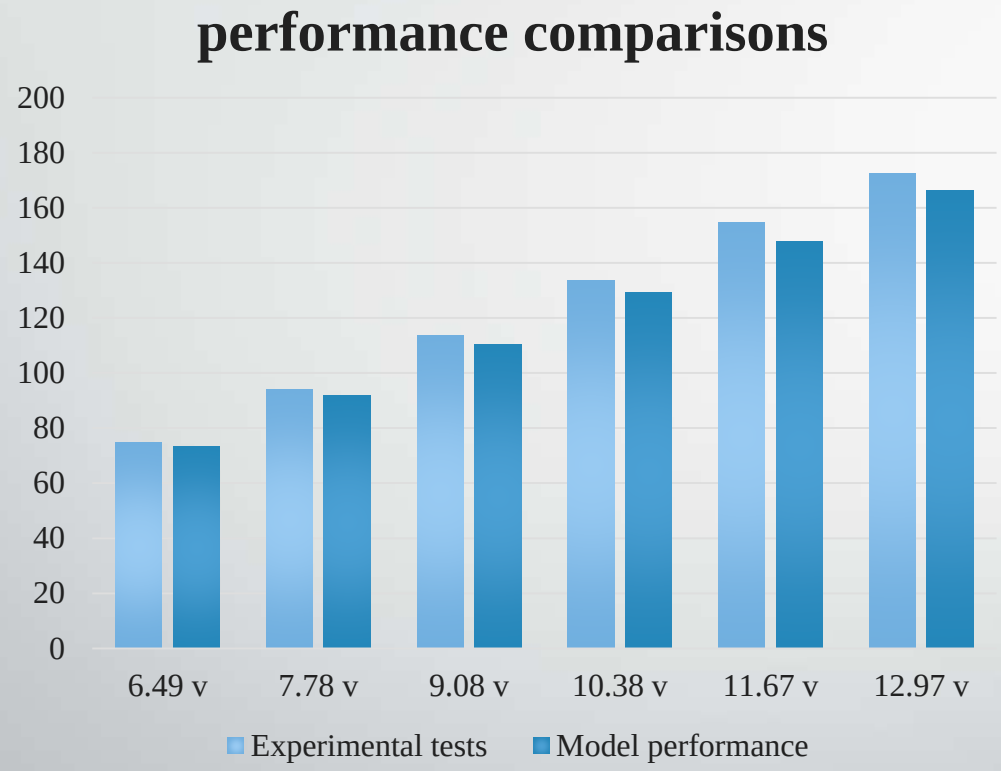
Identification Parameters

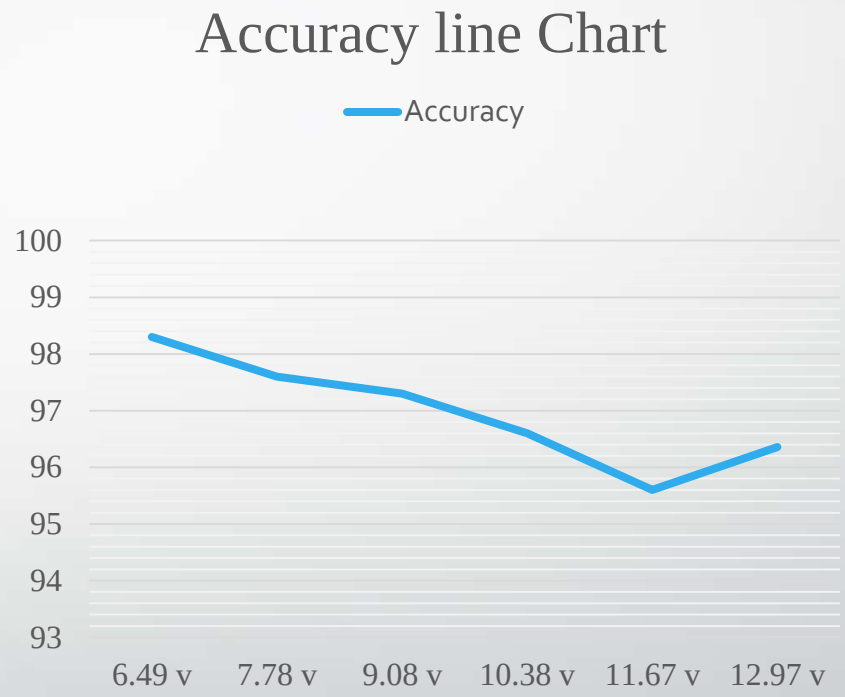
$$J\ddot{\theta} = Kt.i - b\dot{\theta}$$

$$V_s = L\frac{di}{dt} + Ri - Ke\dot{\theta}$$

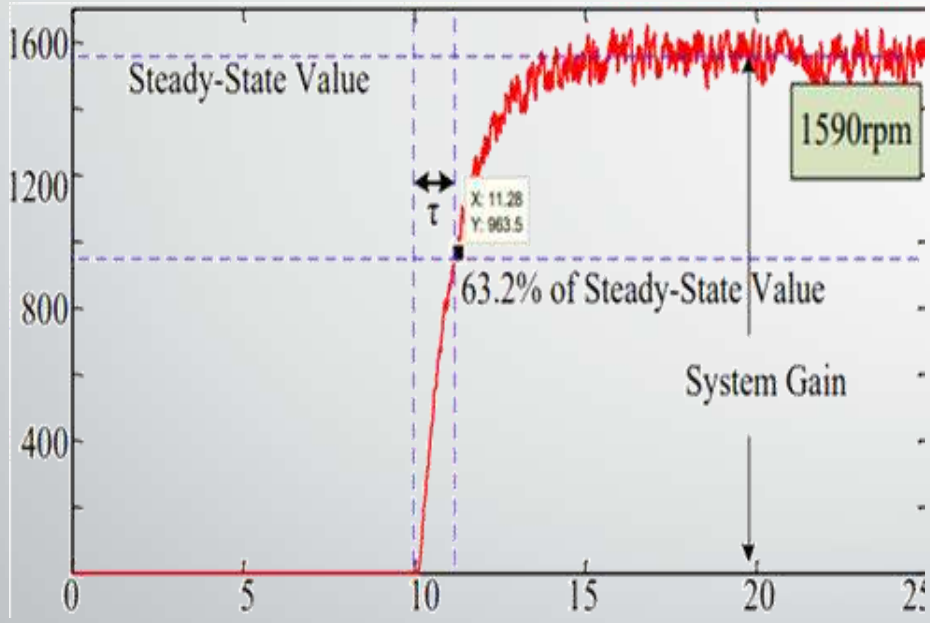


Results

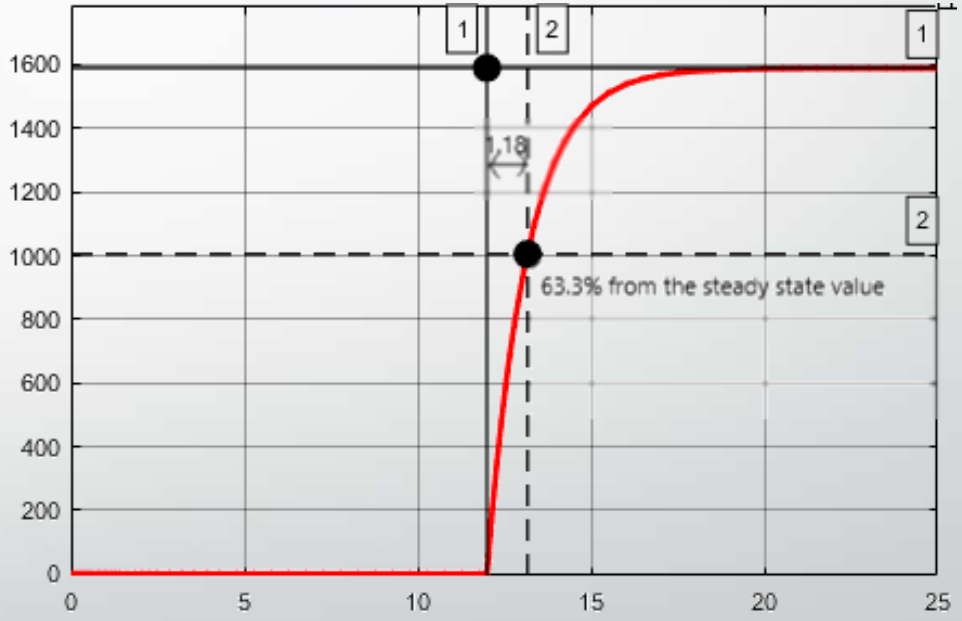

performance comparisons
200
180
160
140
120
100
80
60
40
20
0
6.49 v
7.78 v
9.08 v
10.38 v
11.67 v
12.97 v
Experimental tests
Model performance


Accuracy line Chart
Accuracy
100
99
98
97
96
95
94
93
6.49 v
7.78 v
9.08 v
10.38 v
11.67 v
12.97 v

Results



Real Motor



Model Output

Conclusion

- Mathematical Modelling can be a useful alternative of experimental testing of PMDC motors.
- Each PMDC Motor can be identified by determining five parameters .
- Determining the identifying parameters are sufficient in building a model with a high accuracy.

References

- Alabama, U. o. (2016). types of electric motors. Retrieved from University of Alabama: www.ece.uah.edu
- 2. Chu, H., & Weinan, T. (2016). Speed Control of the Permanent-Magnet DC Motor subjected to Uncertainty and Disturbance. 35th Chinese Control Conference., (pp. 4664-4669). China.
- 3. Tun, Z. M., & Naing, T. L. (2018). PMDC Motor Modelling and Parameter Identification for Control Purpose. research gate.
- 4. Wolm, P., & Chen, X. (2010). Analysis of a PMDC Motor Model for Application in Feedback Design for Electric Powered Mobility Vehicles. International Journal of Computer Applications in Technology.

Thanks For Listening