UNIVERSIDAD MILITAR NUEVA GRANADA

LABORATORY 1:
DC MOTOR IN PARALLEL CONNECTION

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1. RESUMEN:

En esta práctica se llevó a cabo la conexión de un motor DC en paralelo, con el fin de comprobar y demostrar las propiedades principales y el funcionamiento de este. Se hicieron mediciones como lo son la carga, velocidad angular y las corrientes de campo y armadura para luego relacionarlas y conocer las características de este motor.

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2. PALABRAS CLAVE:

-Paralelo

-Corriente de campo

-Corriente de armadura

-Carga

-Torque

-Embobinado

3. ABSTRACT:

In this practice it was performed the connection of a DC motor in parallel, in order to test and demonstrate the main features and operation of this. measurements such as load, angular velocity and field currents and armor and then relate them to find the features of this motor.

4. KEY WORDS:

-Parallel

-Field current

-Core current

-Load

-Torque

-Winding (coil)

5. INTRODUCTION:

Electric direct current motors are devices capable of transforming electrical energy into mechanical energy, in this case a rotational movement. Its operation is based on the force produced by the presence of a conductive material, such as in the form of a coil, excited with an intensity of present current within a magnetic field by a magnet or electromagnet.

When motors have their magnetic field produced by an electromagnet, they have an additional winding inside responsible for behaving like an electromagnet. The motor can have the winding connected in parallel, and thus direct to the power.

6. OBJECTIVES:

GENERAL OBJECTIVE:

- Analyze the characteristics of a motor with parallel connected windings.

SPECIFIC OBJECTIVES:

- Vary the supply voltage, take the different current values in the armature and field winding.
- Observe the current behavior in the windings at different loads.
- Measure and perform a relationship between voltages, currents and angular velocity.

7. THEORETICAL FRAMEWORK

- **Parallel motor:**

The scheme of a shunt self-excitation motor is like that of the figure, where it is observed that the inductor winding is connected in parallel with the winding of the induced, porso in this case the voltage of the network feeds the two branches of the circuit and the current intensity absorbed from the network is distributed between the intensity of the induced.

Then most of the current and excitation intensity will be derived which will be of a very reduced value, the resistance of this branch should be high and due to this the shunt excitation winding is constructed with many turns of fine wire.[3]

8. DESIGN

During the practice the design for a motor with the windings connected in parallel will be carried out. The internal structure of an engine with parallel winding is as follows:

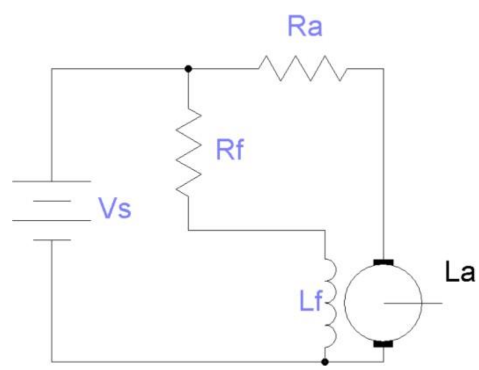


Figure 1: Internal structure.

Formulas:

$$Rf = \frac{Vs}{If} \quad (1)$$

$$Ra = \frac{Vs}{Iarr} \quad (2)$$

$$Ea = Vs - RaIa \quad (3)$$

$$Pd = EaIa \quad (4)$$

$$Pmax = \frac{Vs^2}{4Ra} \quad (5)$$

$$Td = \frac{Pd}{\omega_m} \quad (6)$$

Where:

Rf: Field resistance.

Vs: Source voltaje.

If: Field current.

Ra: Armor resistance.

Iarr: Starting current.

Ea: Voltage against electromotive.

Ia: Armature current.

Pd: Developed power.

Pmax: Maximum power.

Td: Torque developed.

To carry out the practice, the following materials are used:

- Alligator clips
- Three-phase cable
- Tachometer
- Power table
- Multimeter
- Banana-Banana connection cables
- DC Motor
- Electrodynamometer
- Distribution strap
- Voltage source

The simulation helps to have a better understanding of the behavior of the engine, and by varying its values you can find a relationship between the variables that affect its characteristics as shown below:

- Simulation and analysis

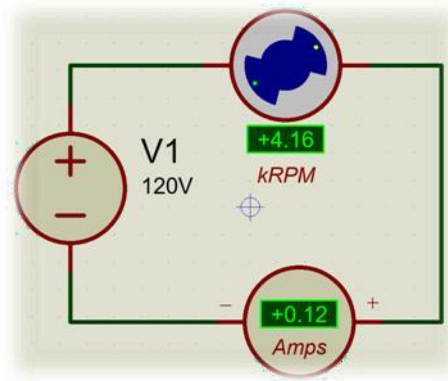


Figure 2. DC Motor simulation

- Test plan:

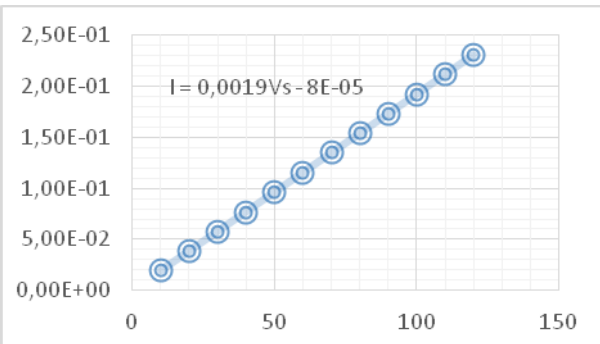
Different simulations are carried out varying its voltage in order to analyze its behavior. In all cases, it will be simulated with a DC motor that possesses a predetermined armature resistance of 10Ω, along with an inductance in the windings of 100mH.

Voltage (v)	*Current (mA)*
10	*19.2*
20	*38.5*
30	*57.7*
40	*76.9*
50	*96.2*
60	*115*
70	*135*

80	*154*
90	*173*
100	*192*
110	*212*
120	*231*

Table 1. Current values as function of voltage

By performing the simulations with 10 different voltage data it can be evidenced that as its voltage increases the current becomes larger, being directly proportional.



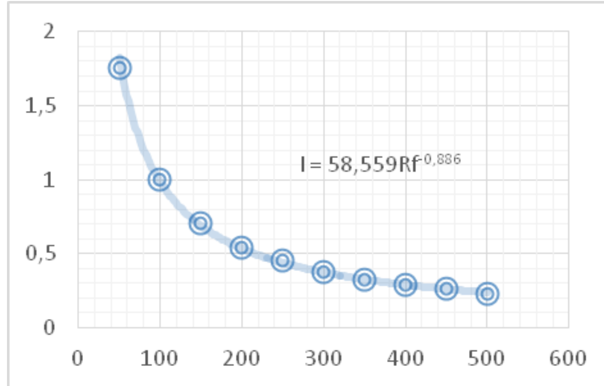
Graph 1. Current as function of voltage

Subsequently, more simulations were carried out, varying the resistance and leaving its voltage constant (120 volts DC), visualizing the behavior of the current with the following data:

Resistance(Ohm)	*Current (A)*
50	*1.76*
100	*1.00*
150	*0.71*
200	*0.545*
250	*0.45*
300	*0.375*
350	*0.32*
400	*0.286*
450	*0.26*
500	*0.231*

Table 2. Current as function of resistance values

When relating current with resistance, the following graph was found:



Graph 2. Current as function of field resistance

Taking into account by Ohm's law that the behavior of the current is inversely proportional to the value of the resistance where a current is produced. Then the current measured in simulation is the total current needed by the motor, so if the field resistance is varied, then the current needed by the motor changes according to the proportionality ratio.

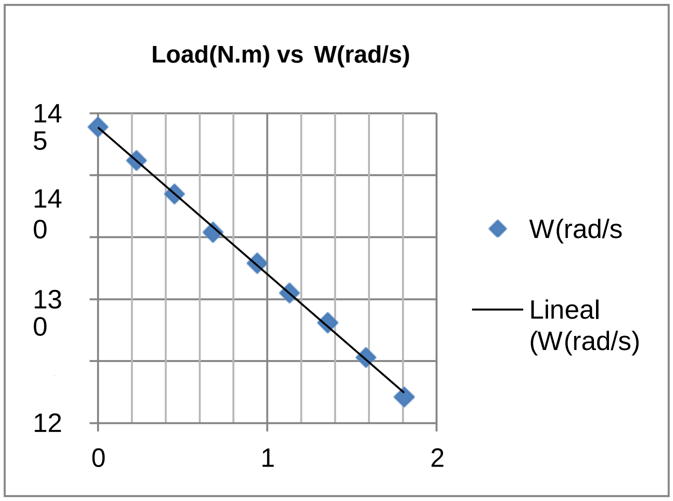
In other words, by reducing the field resistance, the current increases in the winding and because the armature current is theoretically constant, the total current increases. The same thing happens in reverse.

9. EXPERIMENTAL RESULTS

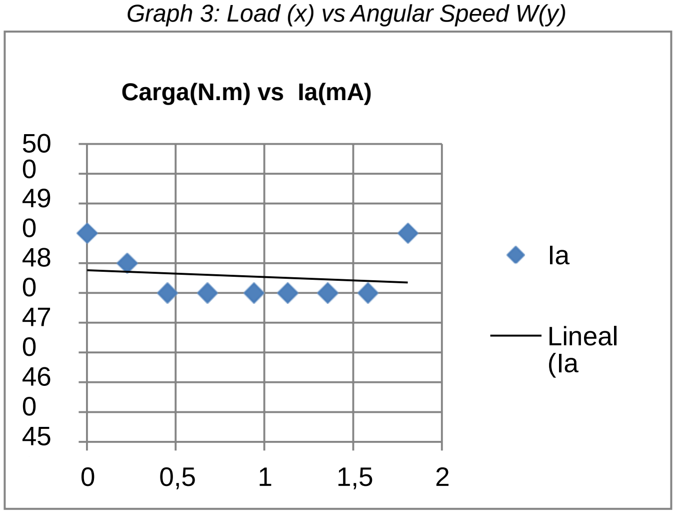
Load (N.m)	Ia (mA)	If (mA)	Angular speed(rad/s)
0	470	10	143,9
0,226	460	10	141,2
0,4519	450	10	138,5
0,6779	450	20	135,4

0,939	450	20	132,9
1,13	450	20	130,5
1,356	450	20	128,1
1,582	450	20	125,3
1,808	470	20	122,1

Table 3: Experimental results



Graph 3: Load (x) vs Angular Speed W(y)



Graph 4: Load(x) vs Current (y)

10. ANALYSIS OF RESULTS:

Table 3 shows the experimental data obtained in laboratory practice. These data were plotted to relate the variables of a DC motor in parallel. In graph 3 it can be seen that the load (N.m) when constantly increased in units of (2lbf.ft)=>(0.226N.m), decreased the speed of the motor when the load was increased..

Then, in graph 4 you have a different behavior, when you vary the load, the current remains constant, except for the deviations presented of approximately 10mA..

Using the equations proposed above, you can do the analysis of the data and calculate the percentage of error presented between the theoretical and experimental values. For equation (6) where you want to find the torque, you already have the value of the speed but you do not yet know the power developed, as you do not have the voltage in the Armature Ea.

$$Ea = Vs - RaIa \quad (3)$$

$$Pd = EaIa \quad (4)$$

$$Td = \frac{Pd}{\omega_m} \quad (6)$$

Vs= 120v

Ra≈10Ω

Ia= 450mA

Wm=138,5rad/s (In this case)

$$Td = \frac{(Vs - RaIa) * Ia}{\omega_m}$$

$$Td = \frac{(120v - 10\Omega * 450mA) * (450mA)}{138{,}5rad/s}$$

$$Td = 0{,}38N.m$$

The experimental value of torque for when the speed was 138.5rad/s, is 0.4519 which would be the experimental value..

$$Error = \frac{|Valor_{teórico} - Valor_{experimental}|}{Valor_{teórico}} * 100$$

$$Error = \frac{|0{,}38N.m - 0{,}45N.m|}{0{,}38N.m} * 100$$

$$Error = 18{,}42\%$$

There was an error of 18.42% between the theoretical value and the experimental value of the torque for an instant of the engine.

11. CONCLUSIONS

When using the parallel connection of the motor, the current does not vary when a load is applied to the motor or when the speed of the motor decreases, this according to the results obtained in practice and contained in Table 3..

When the motor was connected directly to the rated voltage, it could not withstand the maximum load allowed by the dynamometer. This is why we must know the maximum torque allowed by a DC motor in parallel, so that the motor does not stop or on some occasions, is damaged.

12. BIBLIOGRAPHY

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