جامعة محمد بوضياف- المسيلة -
Mohamed Boudiaf University at M'sila
كلية التكنولوجيا
Faculty of Technology
قسم الهندسة الكهربائية و قسم الإلكترونيك
Department of Electrical Engineering and Department of Electronics

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University year: 2024/2025 — السنة الجامعية :2024 /2025
2nd year Electrical Engineering and Electronics — السنة الثانية هندسة كهربائية و إلكترونيك
Applied Work in Fundamentals of Electrotechnics 1 — أعمال تطبيقية في الكهروتقني الأساسية 1

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PW n°05 : Direct current machines

Duration : 1^h30.

Date of the experiment: ……. /……../…….. .

Report prepared by:

Last Name	**First Name**	**Group**	**S/Group**	**Final Note**
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Instructions :

- **Internal laboratory regulations must be observed.**
- **You must wear a lab coat.**
- **Attendance is compulsory and will be monitored. Any unjustified absence or failure to hand in a report will result in a mark of 0/20.**
- **Have your assemblies checked before connecting the voltage source.**
- **It is strictly forbidden to move equipment from one station to another. In the event of a breakdown or faulty equipment, contact the teacher.**
- **The report must be written by a maximum of four students.**
- **The report must be handed in at the beginning of the next session.**
- **The report must include the following sections:**
  - **TP cover page.**
  - **The date of the practical session.**
  - **Last Name and first name of the main writer.**
  - **Last Names and first names of the WP participants.**
  - **Preparation and work in manuscript.**

I- Aim of the manipulation:

General study of a direct current machine for both generator and motor modes of operation.

II- Equipment used:

- DC voltage sources.
- Rheostats.
- Measuring instruments (voltmeters, ammeters, multimeters).
- Separately excited generators.
- Separately excited motors.

III- Theoretical reminder:

1. Description :

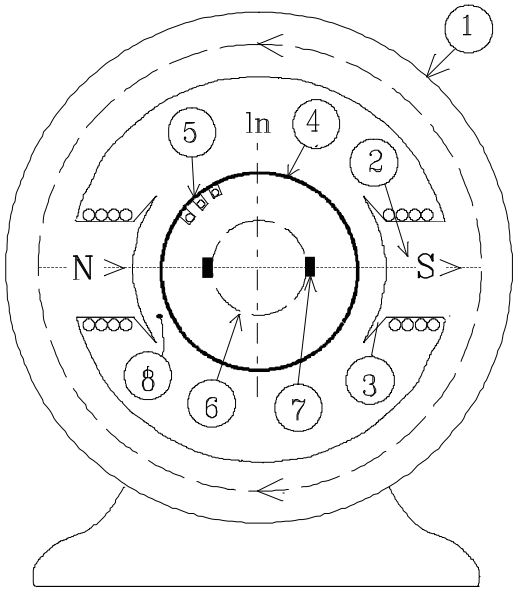


Figure1

It consists of 2 main parts:

- The fixed part : Stator or inductor
- The moving part: Rotor or armature

1: Machine frame. It supports the fixed parts (poles). It closes the magnetic circuit (dotted field line).

2: Main poles (laminated). The field is generated by the magnetising coils * field circuit (**Iex**) or by permanent ferrite magnets. **Ln** is the neutral line where the magnetic field is cancelled and then reversed.

3: Laminated poles. They make it possible to increase the field area.

4: Laminated rotor.

5: Notches. These contain the conductors that are the seat of the induced **e.m.f** when this part rotates in the field: induced circuit.

6: The commutator (copper blades insulated with mica), located at the end of the rotor and mounted on the same shaft.

7: Brushes: These are fixed to the frame by means of the brush holder. They are made of carbon and rub against the commutator. They are located on the axis of the main poles.

8: The air gap.

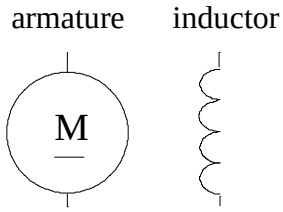


Figure2: Direct current machine symbol

2. Principle and reversibility of the DC machine

2.1. A reminder of electromagnetism:

-Lenz's Law: An induced e.m.f. is created in a conductor subjected to a flux variation (here a conductor moving in the field e=-dφ/dt ou <e>=$|\Delta\Phi/\Delta t|$. The direction of this e.m.f. is given by the rule of the 3 fingers of the left hand.

-Laplace force: An electromagnetic force is created on a conductor carrying a current and placed in a magnetic field: the direction of this force is given by the rule of the 3 fingers of the right hand:

$\vec{F} = I\vec{l} \wedge \vec{B}$ et F=Iℓ B sin (I $\vec{l}$,$\vec{B}$)

2.2. Operating principle and reversibility:

Generator

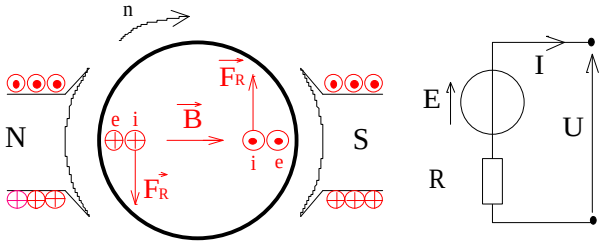


Figure 3

Rotation creates an induced **e.m.f** which supplies a current. This current creates electromagnetic forces and a resistive torque.

The polarity of the DC machine (generator) is reversed:

- The direction of rotation
- The exciting current **Iex** (F and B).

Motor

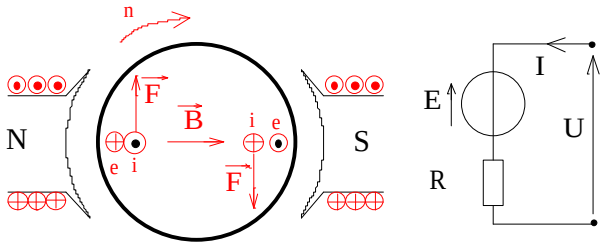


Figure 4

The power supply creates a current which generates electromagnetic forces and a motor torque. Rotation occurs and induced **e.m.f** is created.

Pe = EI $\Rightarrow$Pm= TΩ

The direction of rotation of the DC machine (motor) is reversed by inversion:

- The field current **Iex**.

-The supply voltage.

3. Role of the collector

It rectifies the **e.m.f** at the terminals of a winding to obtain an always positive **e.m.f.**

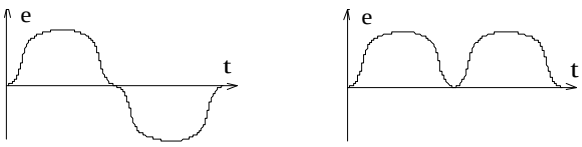


Figure 5

4. Basic characteristics of the DC machine

a. Induced electromotive force E:

$E=\frac{N}{2}\Delta\Phi/\Delta t=\frac{N.2.\Phi}{2.1/n}=N.n.\Phi=\frac{N.\Omega.\Phi}{2\pi}=K.\Phi.\Omega$. $\boxed{E=K.\Phi.\Omega}$: general relationship

If the flux **Φ** is constant (constant excitation current (**Iex**) or permanent magnet), the **e.m.f** is proportional to the speed n $\boxed{E=k.n}\Rightarrow E/E'=n/n'$.

b. Power (Pe) and electromagnetic torque (Te) :

Electrical power is converted into mechanical power and vice versa. This is electromagnetic power: Pe=E.I=Te.Ω

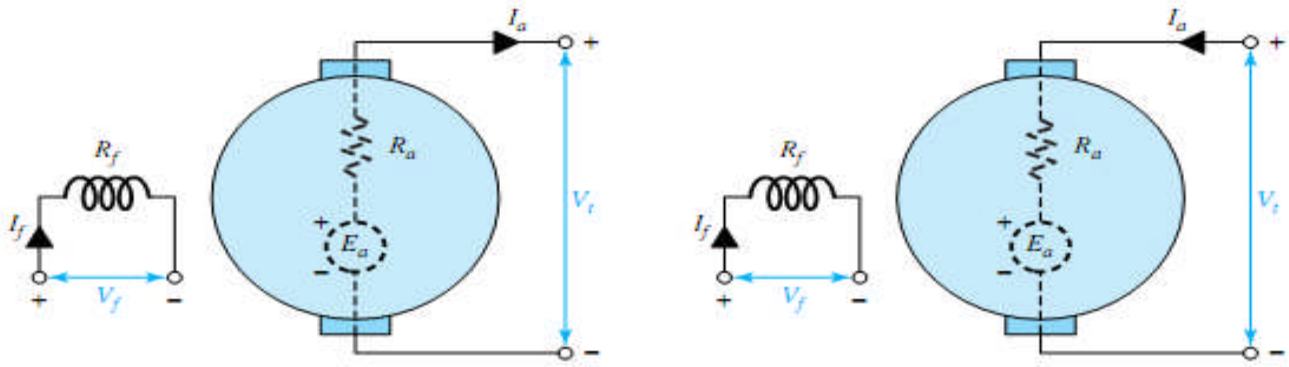
Te = Pe/Ω = E.I/Ω= K.Φ.I.

Te in Nm ,

Pe in W , Ω in rad/s

Person in charge of practical work: Dr ROUABHI.R

c. Mode of operation:



Generator U= Ea-Ra.Ia Figure 6 **Motor Ea+Ra.Ia**

Practical part:

1. Separately excited no-load generator:

- **Variation of the electromotive force e.m.f. with excitation: E(Iex). =cte=1500rpm**

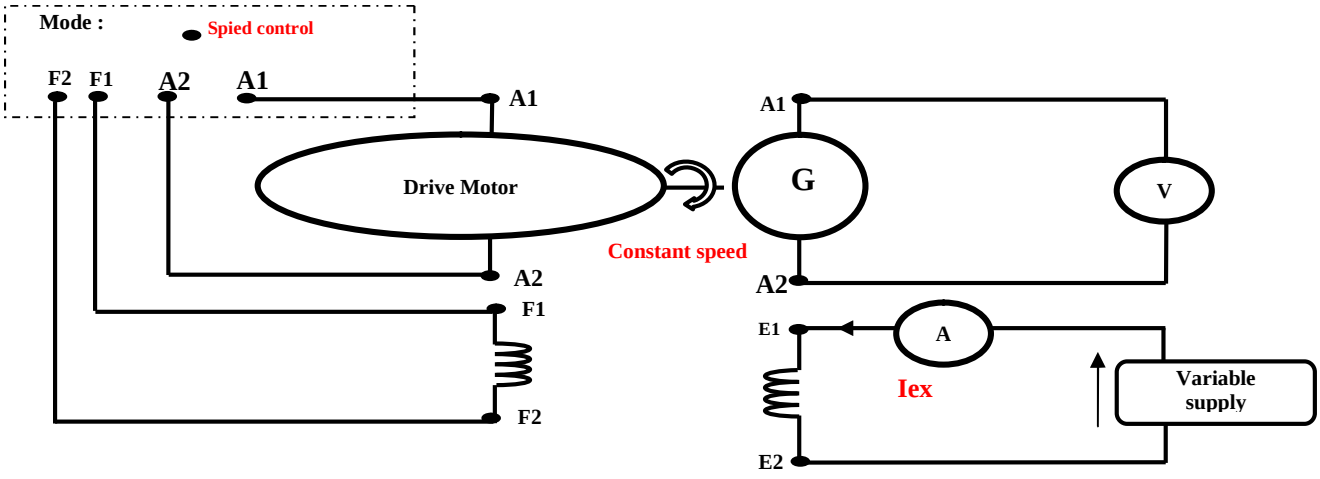


Figure 7

The armature is no-load Uv = E
-The field winding, the excitation circuit, behaves as a resistor and Vex=(Rh+rex)Iex
1) Make the circuit shown in figure 7.
2) Complete the following table.

Iex(A)	0							
U_V=E(V) Iex ↗								
U_V=E(V) Iex ↘								

3) Plot the curve E= f(Iex) in Figure 8.

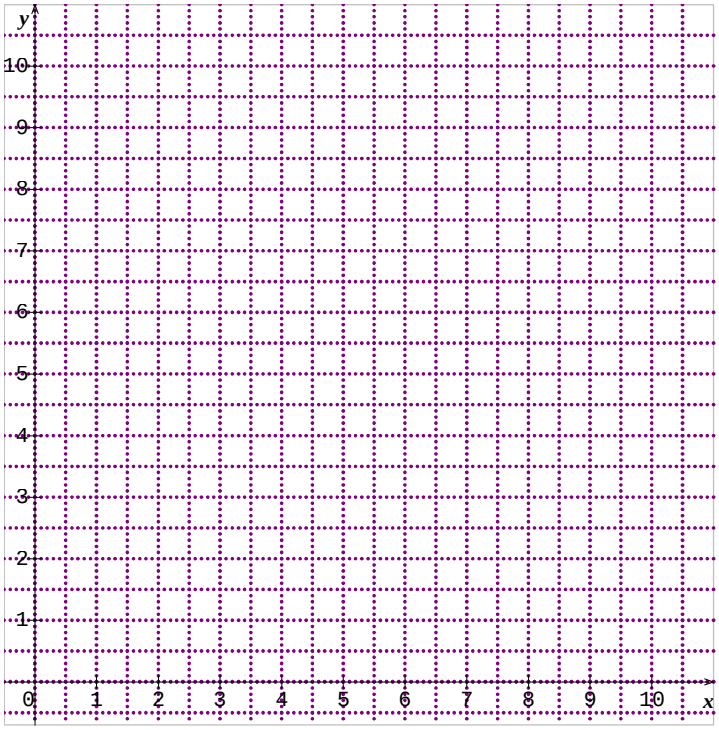


Figure 8

4) Interpret the curve E= f(Iex) and conclude.

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5) determine the value of the remanent electromotive force.

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……Er =……V.

2. Separately excited no-load motor:

- **Variation of the rotation speed n (rpm) with the supply voltage U(V):**

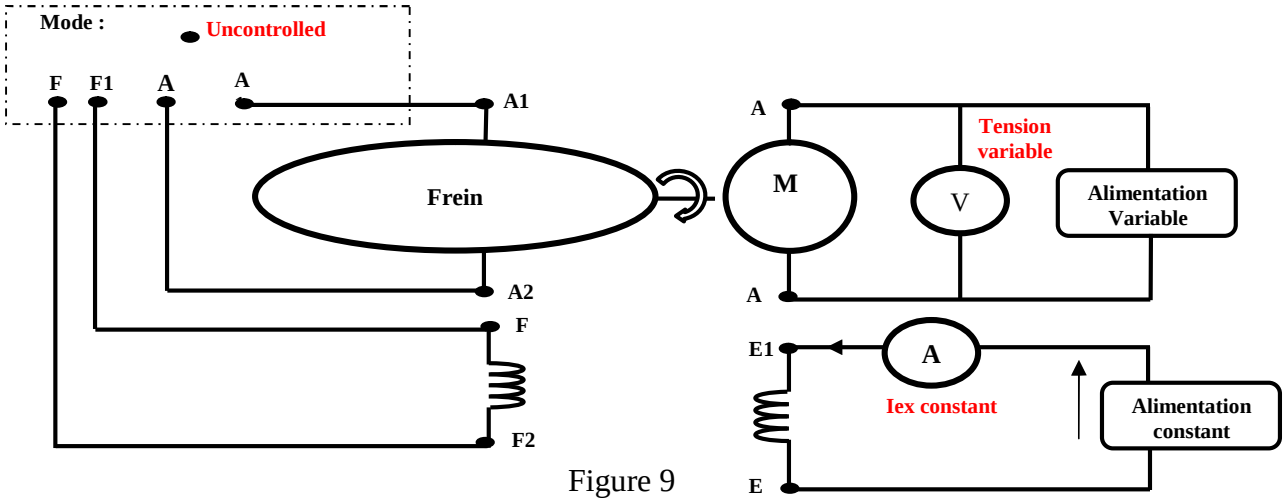

Figure 9

1) Carry out the assembly as shown in figure 9. Iex = 0.16A = cte
2) Complete the table above

U(V)	0	10	20	30	40	50	60	70	80
n (rpm)									

3) Plot the curve n= f(U) in Figure 10..

4) Interpret this graph and find the expression for the function f.

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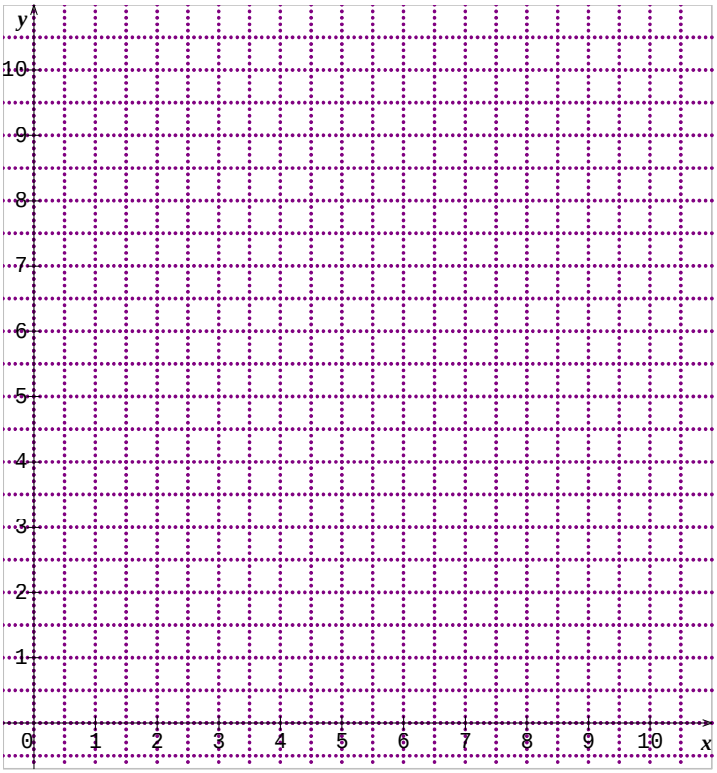

Figure 10

Conclusion :

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