OMKAR SAVANT 43
FYCM

Introduction :

Direct Current (D.C) is the unidirectional Flow of an electric charge. An electrochemical cell is a prime example of DC power. Direct Current may Flow through a conductor such as a coire, but can also Flow through semiconductors, insulators, ore even through a vacuum or in electron or ion beam.

A DC motor is any of a class of rotary electrical motors that convert direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic field. Nearly all types of DC motor have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

A DC generator converts mechanical energy into electrical energy. Whereas a DC motor converts the electrical energy into mechanical energy.

History:

The First Commutator DC electric motor capable of turning machineary was invented by British Scientist William Sturgeon in 1832. Following Sturgeon's work, a Commutator-type direct-current electric motor was built by American inventor Thomas Davenport, which he patented in 1837. The motor ran at up to 600 revolutions per minute, and power machine tools and a printing press. Due to the high cost of primary battery power, the motors were commercially unsuccessful and bankrupted Davenport.

A benefit to DC machine came from the discovery of the reversibility of the electric machine, which was announced by Siemens in 1867 and observed by Pacinotti in 1869. Gramme accidently demonstrated it on the occasion of the 1873 Vienna World's Fair, when he connected two such DC devices upto 2 Km from each other, using one of them as a generator and the other as motor.

DC Machines :

DC machines are basically of two types:

1. D.C. Generator.
2. D.C. motor.

A dc generator is rotated by a prime mover and produces a dc voltage. So it converts mechanical energy into electrical energy.

A dc motor receives energy from a d.c voltage source and rotates at a speed proportional to the applied voltage. So a dc motor converts the electrical energy into a mechanical energy.

Operation of DC motor :

i] When a current carrying conductor is placed in a magnetic field, it experiences a Force.

ii] In case of a DC motor, the magnetic field is developed by the field current i.e the current flowing in the field winding.

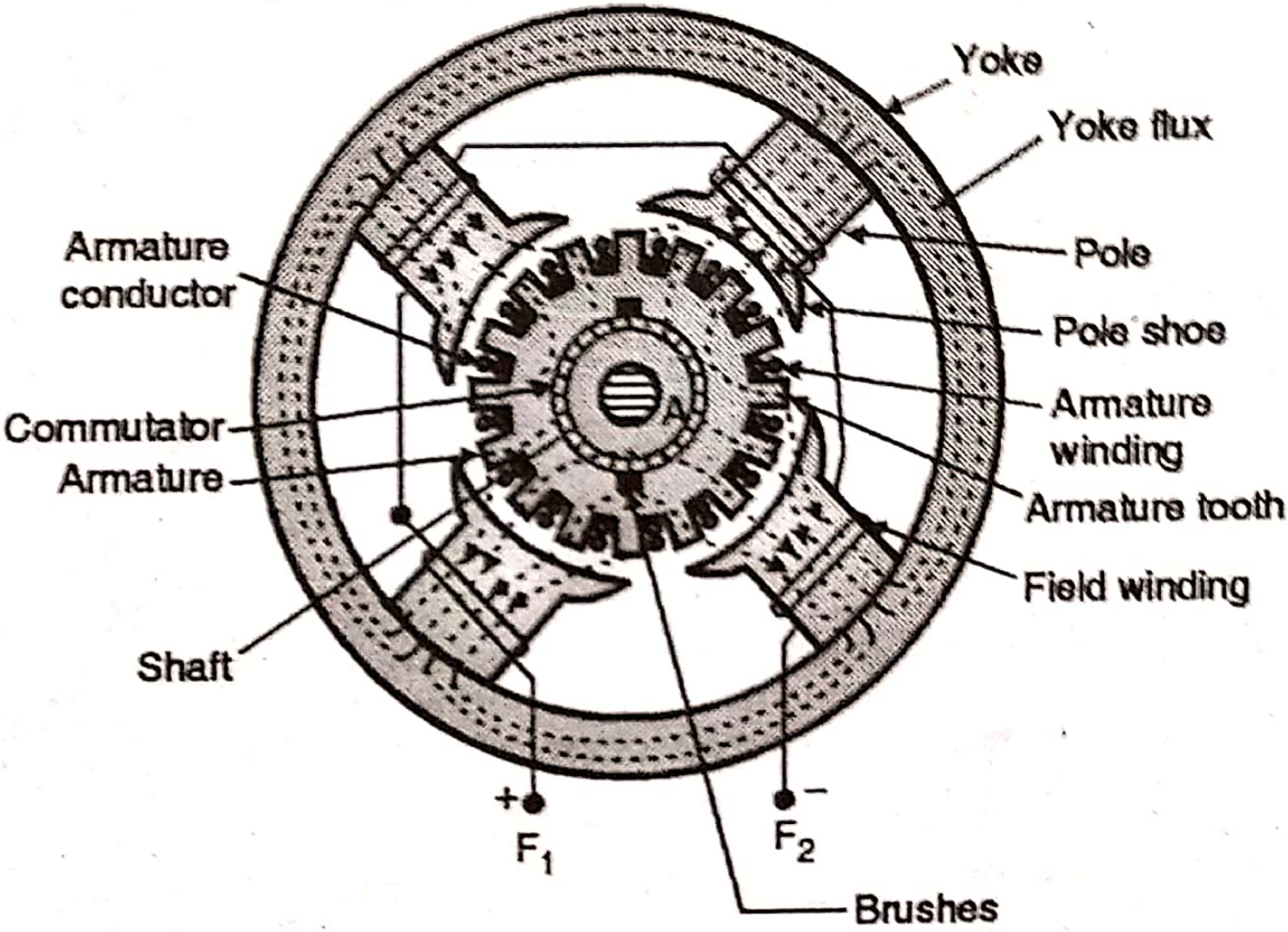
iii] The armature winding is connected to an external dc source, hence it plays the role of the current carrying conductor placed in magnetic field.

iv] Due to the force exerted on it when placed in the magnetic field, it starts rotating and the armature starts rotating.

v] The direction of rotation depends on the direction of the magnetic field produced by the field winding as well as the direction of magnetic field produced by the armature.

5.5 Construction of a DC Machine :

Fig. 5.5.1 shows the construction of a DC machine. The construction of a DC generator is same as that of a DC motor.



(A-1045) **Fig. 5.5.1 : Construction of a dc generator**

Important part of DC machine :

i] Yoke
ii] Field winding
iii] Poles
iv] Armature
v] Commutator, brusher and gear
vi] Bearing

i] Yoke

1] Yoke is also called as frame. It provides protection to the rotating and other parts of the machine from moisture, dust, etc.
2] Yoke is an iron body which provides the path for the flux. This essential to complete the magnetic circuit
3] It provides the mechanical support for the poles.
4] Materials used for yoke are basically the low reluctance material.

ii] Field Winding

1] The coils wound around the poles cores are called field coils.
2] The field coils are connected in series with each other to form the field winding.
3] The field winding is also called as Exiting winding.
4] The material used for winding is copper.

iii] Armature Winding

1] The armature conductors made of copper are placed in the armature slots present on the periphery of armature core.
2] These armature conductors are interconnected to form the armature winding.
3] When the armature winding is rotated using a prime mover, it cuts the magnetic flux lines and voltage gets induced in it.
4] Armature winding is connected to the external circuit through commutator and brushes.

iv) Commutator:

1] A Commutator is a cylindrical drum mounted on the shaft alongwith the armature core.
2] It is made of a large number of wedge shaped segments of hard-drawn Copper.
3] The segments are insulated from each other by thin layer of mica.
4] The armature winding is tapped at various points and are connected to commutator.

v] Brushes:

1] Commutator is rotating. So it is not possible to connect the load directly to it.
2] Hence current is conducted from the armature to the external load by the carbon brushes which are held against the surface of commutator by springs.
3] Brushes wear with time. Hence they should be inspected regularly and replaced occasionly.

* Back EMF :

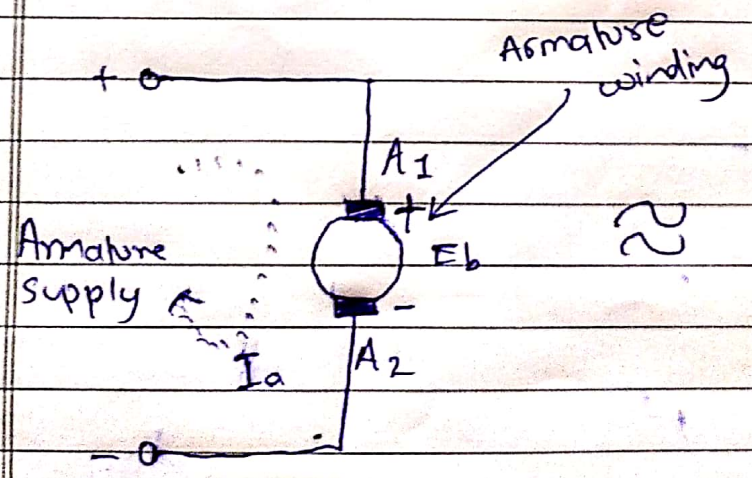
1] When the armature winding of a dc motor starts rotating in the magnetic flux produced by the field winding, it cuts the lines of magnetic flux.

2] Hence according to the Faraday's law of electromagnetic induction, there will be an induced emf in the armature winding.

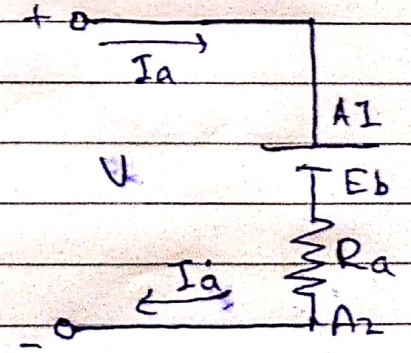
3] As per the Lenz law's, this induced EMF acts in opposite direction to the armature supply voltage. Hence this emf is called as back emf and is denoted by E_b.

4] It is expressed as,

$$E_b = \frac{P \phi N Z}{60 A} \text{ Volts}$$



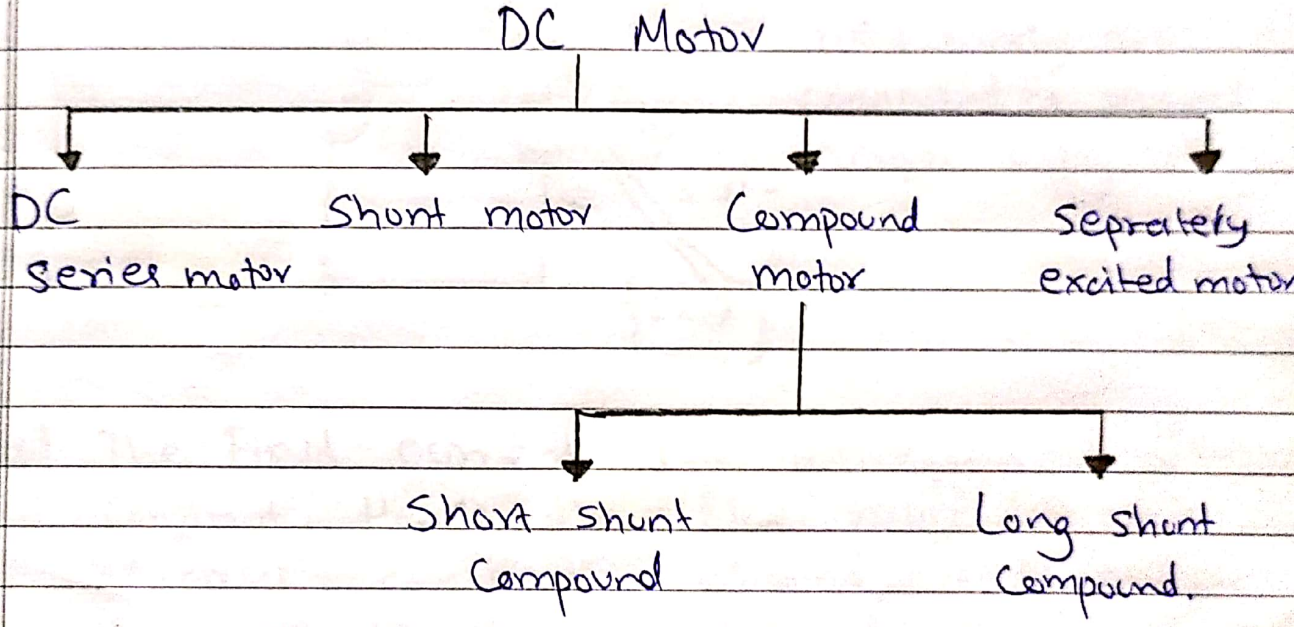
Back emf



Equivalent circuit

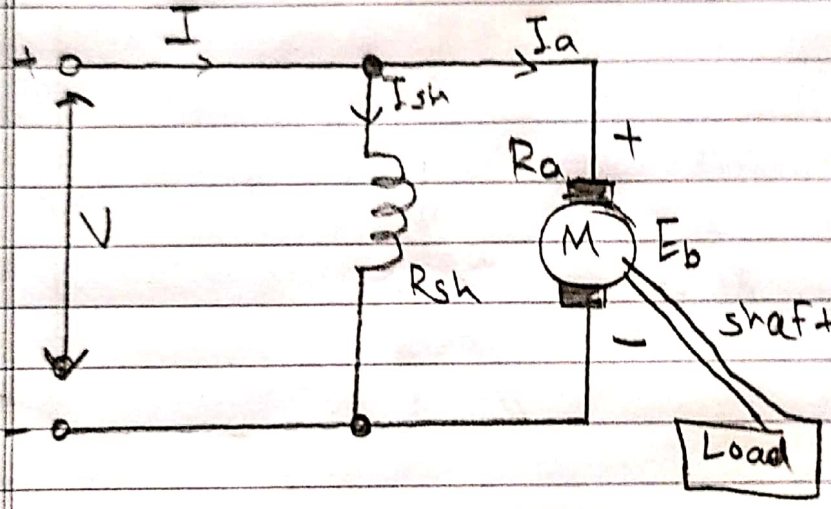
Types of DC Motor:

Depending on the way of connecting the armature and field windings of d.c. motor, the d.c. motors are classified as follows:



DC Shunt Motor :

In the D.C Shunt motor, the armature and field winding are connected in parallel as shown. The parallel combination of the two windings is connected across a common dc power supply.



The armature and field winding are connected in parallel across supply voltage.

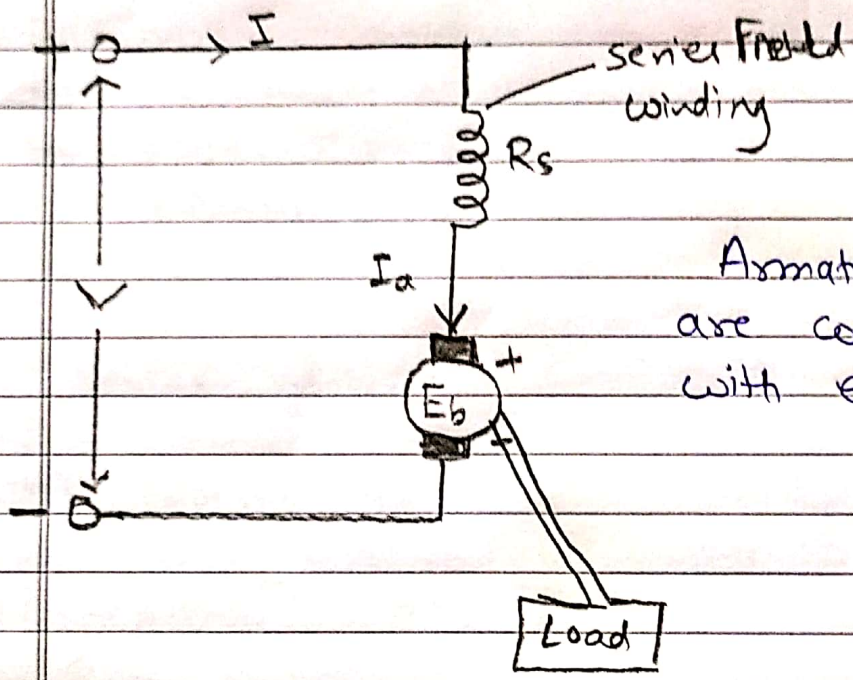
1] The field current Ish always remains constant. Hence the flux produced also remains constant, because field current is responsible for generation of flux.

$$\therefore \phi \propto I_{sh}$$

2] Hence, the shunt motor is also called as the constant flux motor.

DC Series Motor:

In the D.C. series motor, the armature and field windings are connected in series with each other as shown:



Armature and field windings are connected in series with each other.

1) The armature current I_a and hence the field current I_s will be dependant on the load. With increase in load I_a and I_s will increase.

$\therefore \quad \phi \propto I_a$

$\therefore \quad \phi \propto I_s$

2) Hence in a dc series motor the flux ϕ does not remain constant. So the DC series motor is not a constant flux motor

* Applications :-

i] Shunt Motor :

1] Various machines such as drilling machine, milling machine, etc.
2] Printing Machinery
3] Paper machines
4] Centrifugal pomps
5] Blowers and fans

ii] Series Motor :

1] Electric train
2] Diesel-electric locomotive.
3] Cranes
4] Trolley car & bus
5] Rapid-transit system
6] Conveyers.

iii] Compound Motor :

1] Elevator
2] Rolling Mill
3] Punches
4] Shears
5] planers

Conclusion :

Electric motors revolutionized the industry. Industrial processes were no longer limited by power transmission using line shafts, belts, compressed air or hydraulic pressure. Instead, every machine could be equipped with its own power source, providing easy control at the point of use, and improving power transmission efficiency.

Electric motors applied in agriculture eliminated human and animal muscle power from such task as handling grain or pumping water. Household uses of electric motor reduced heavy labor in the home and made higher standards of convenience, comfort and safety possible. Today, electric motors consume more than half of the electric energy produced.