- Diploma in Engineering.
- Fourth Semester.
- Subject: DC Machines -66742
- Chapter-06
- Topic: Understand the principle of winding of DC generator.

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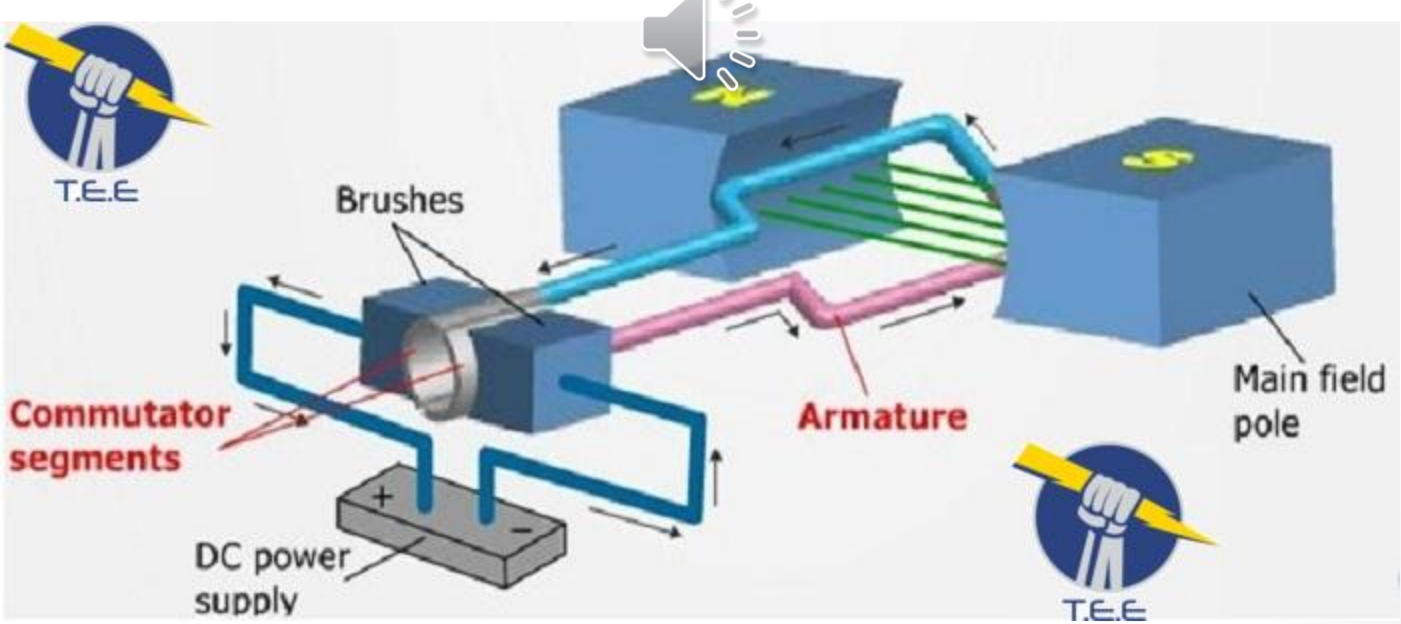
Chapter-12

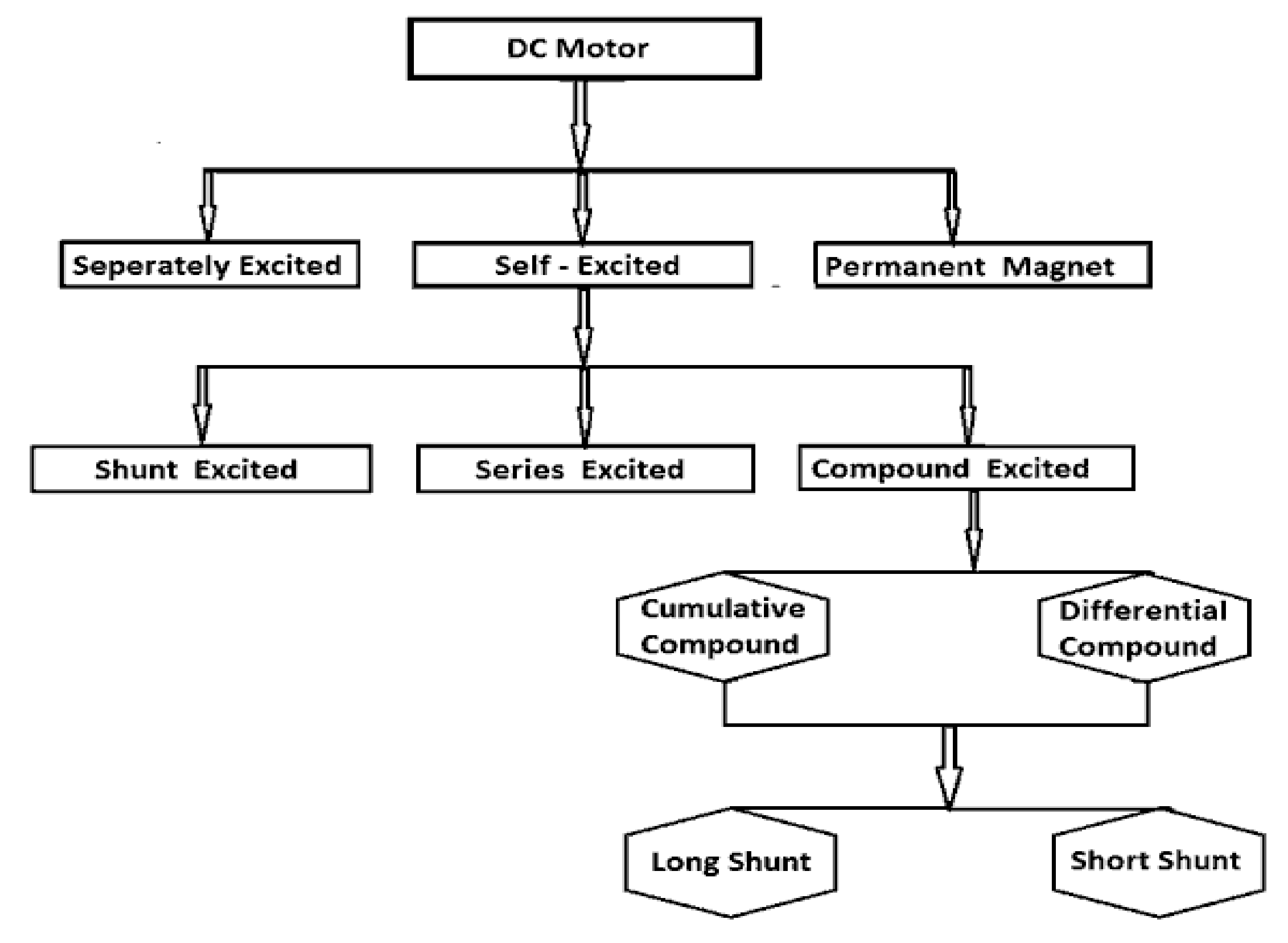
12.1 Understand the working principle of DC motor.

Working principle of a DC motor :

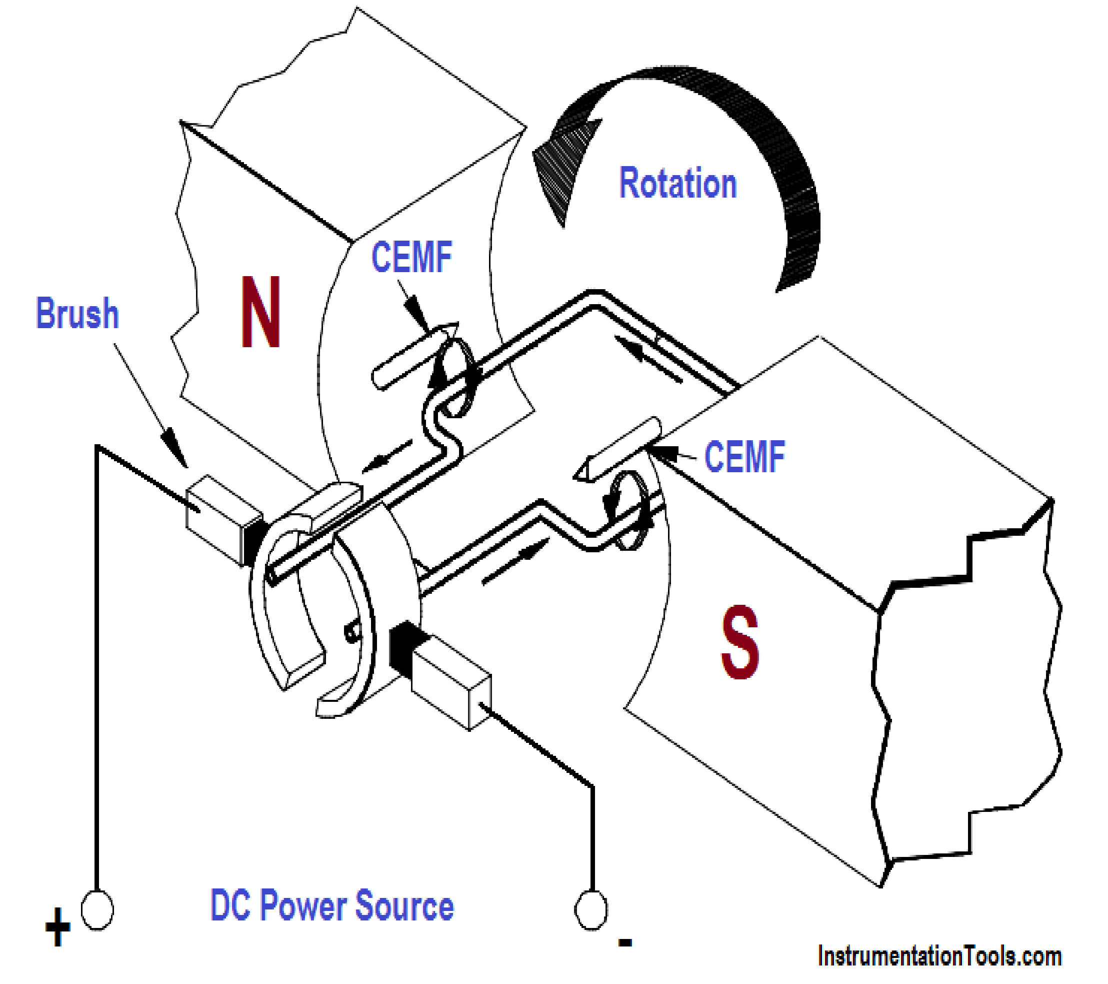
An electric motor is an electrical machine which converts electrical energy into mechanical energy. The basic **working principle of a DC motor** is: "*whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force".* The direction of this force is given by Fleming's left-hand rule and its magnitude is given by F = BIL. Where, B = magnetic flux density, I = current and L = length of the conductor within the magnetic field.



12.2 Mention the types or Classification of DC Motor.



12.3 Explain generator action of motor.



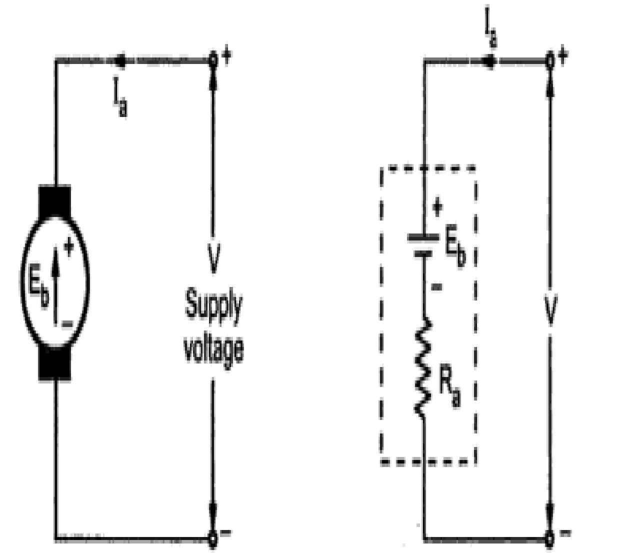
Generator Action in a Motor. A generator action is developed in every motor. When a conductor cuts lines of force, an EMF is induced in that conductor. Current to start the armature turning will flow in the direction determined by the applied DC power source.

What is Back EMF in DC Motor?

We know whenever conductor cuts the magnetic field,e.m.f will induce in conductor.This also applies for conductors in armature too.When the armature of a d.c. motor rotates under the influence of the driving torque, the armature conductors move through the magnetic field and hence e.m.f. is induced in them as in a generator. The induced e.m.f. acts in opposite direction to the applied voltage V (Lenz's law) and in known as back e.m.f or counter e.m.f. denoted with Eb.

Net voltage across armature circuit = V – Eb

If Ra is the armature circuit resistance, then, Ia = (V – Eb)/Ra .



(a) Back e.m.f. in a d.c. motor (b) Equivalent c

The back emf Eb(= PΦZN/60 A) is always less than the applied voltage V, although this difference is small when the motor is running under normal conditions.

The significance of Back EMF

Back emf is very significant in the working of a dc motor.**The presence of back emf makes the d.c. motor a *self-regulating machine*** i.e., it makes the motor to draw as much armature current as is just sufficient to develop the torque required by the load.

Armature current (Ia),

$$I_a = \frac{V - E_b}{R_a}$$

When the motor is running on no load, small torque is required to overcome the friction and windage losses. Therefore, the armature current Ia is small and the **back emf** is nearly equal to the applied voltage.

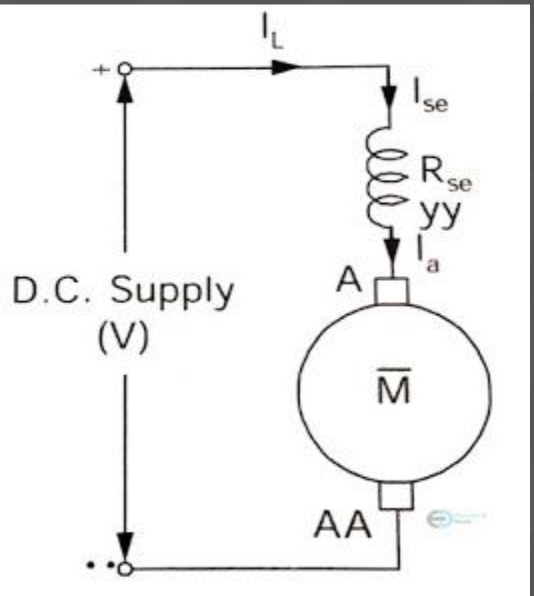
If the motor is suddenly loaded, the first effect is to cause the armature to slow down. Therefore, the speed at which the armature conductors move through the field is reduced and hence the **back emf** Eb falls.

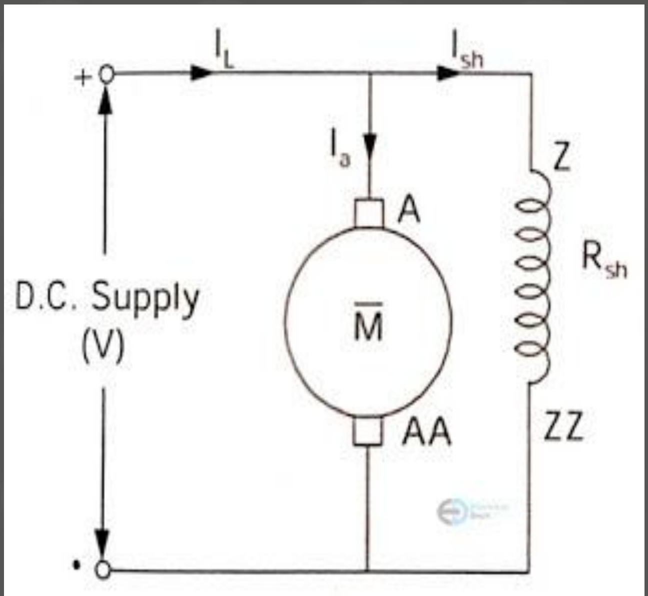
If the load on the motor is decreased, the driving torque is momentarily in excess of the requirement so that armature is accelerated.

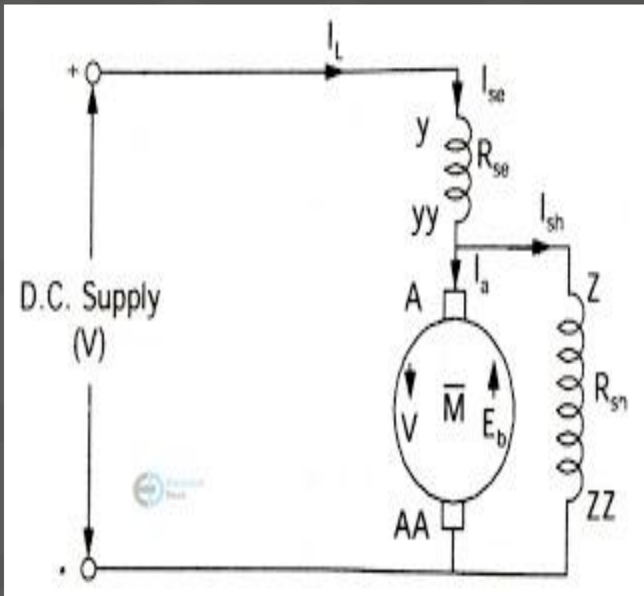
As the armature speed increases, the **back emf** Eb also increases and causes the armature current Ia to decrease. The motor will stop accelerating when the armature current is just sufficient to produce the reduced torque required by the load.

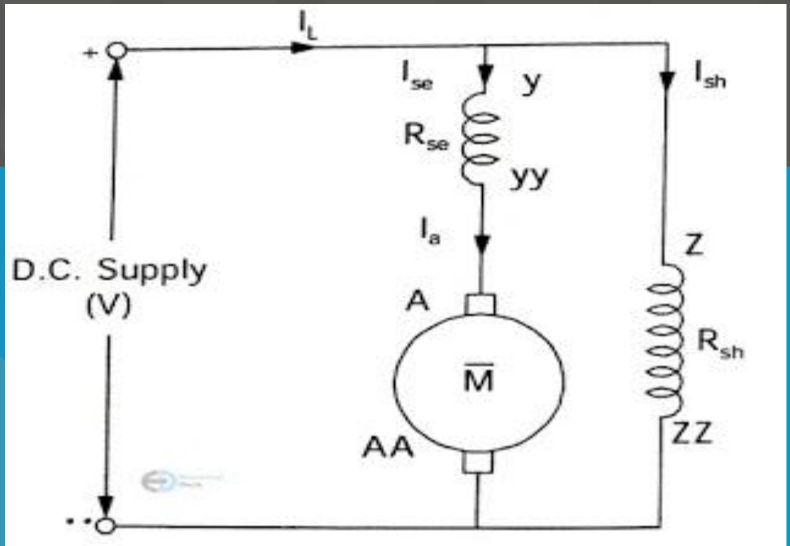
Therefore, the **back emf** in a DC motor regulates the flow of armature current i.e., it automatically changes the armature current to meet the load requirement.

12.5 Express the deduction of voltage equation of motor.









Back emf Equation of Diff: DC Motor :--

DC Shunt Motor :

$I_L = I_a + I_{sh}$

$V = E_b + I_a R_a + BCD$

DC Series Motor :

$I_L = I_{se} \quad R_{se} = I_a$

$V = E_b + I_{se} R_{se} + I_a R_a + BCD$

$= E_b + I_a (R_{se} + R_a) + BCD$

Short Shunt Compound Motor :

$I_L = I_{se} = I_a + I_{sh}$

$$I_{sh} = \frac{V + I_{se} + R_{se}}{R_{sh}}$$

$V = E_b + I_{se} R_{se} + I_a R_a + BCD$

Long Shunt Compound Motor :

$I_{se} = I_a$

$I_L = I_{se} + I_{sh} = I_a + I_{sh}$

$V = E_b + I_{se} R_{se} + I_a R_a + BCD$

Where Ra = armature resistance

Induced e.m.f or Back e.m.f.,= E_b

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

Where BCD = brush contact drop (usually 1V / brush)

R_a = armature (winding) resistance

I_L= Load Current

I_{sh} = Shunt Current

I_a = Armature Current

12.6 Define the term torque (mentioning its unit), running torque and break down torque.

What is break down torque of a DC Motor ?

The maximum torque that a motor can develop at its rated applied voltage and frequency without an abrupt drop in speed.

What is Running torque of a DC motor ?

The **torque** of the **DC Motor** is proportional to the field flux and the armature current. In the **DC** shunt **motor** the flux is constant, therefore the **torque** is proportional to the armature current. Google uses 200+ ranking factors.

Torque T = F × r (N-m) ...where, F = force and r = radius of the armature Work done by this force in once revolution = Force × distance = F × 2πr

(where, 2πr = circumference of the armature)

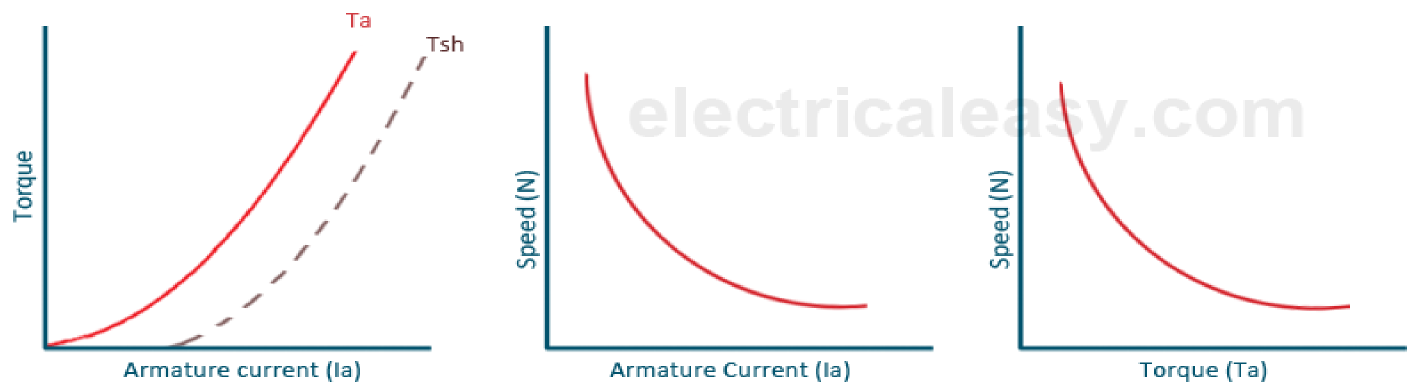
Characteristics of DC motors :

Generally, three characteristic curves are considered important for DC motors which are, (i) Torque vs. armature current, (ii) Speed vs. armature current and (iii) Speed vs. torque. These are explained below for each type of DC motor. These characteristics are determined by keeping the following two relations in mind.

$T_a \propto \phi . I_a$ and $N \propto E_b/\phi$

These above equations can be studied at - emf and torque equation of dc machine. For a DC motor, magnitude of the back emf is given by the same emf equation of a dc generator i.e. $E_b = P\phi NZ / 60A$.

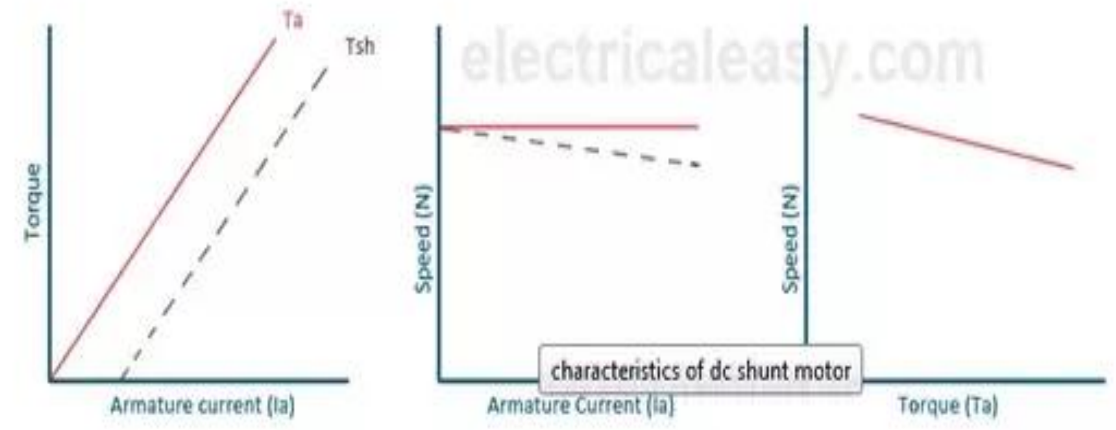
For a machine, P, Z and A are constant, therefore, $N \propto E_b/\phi$



Characteristics of DC series motor

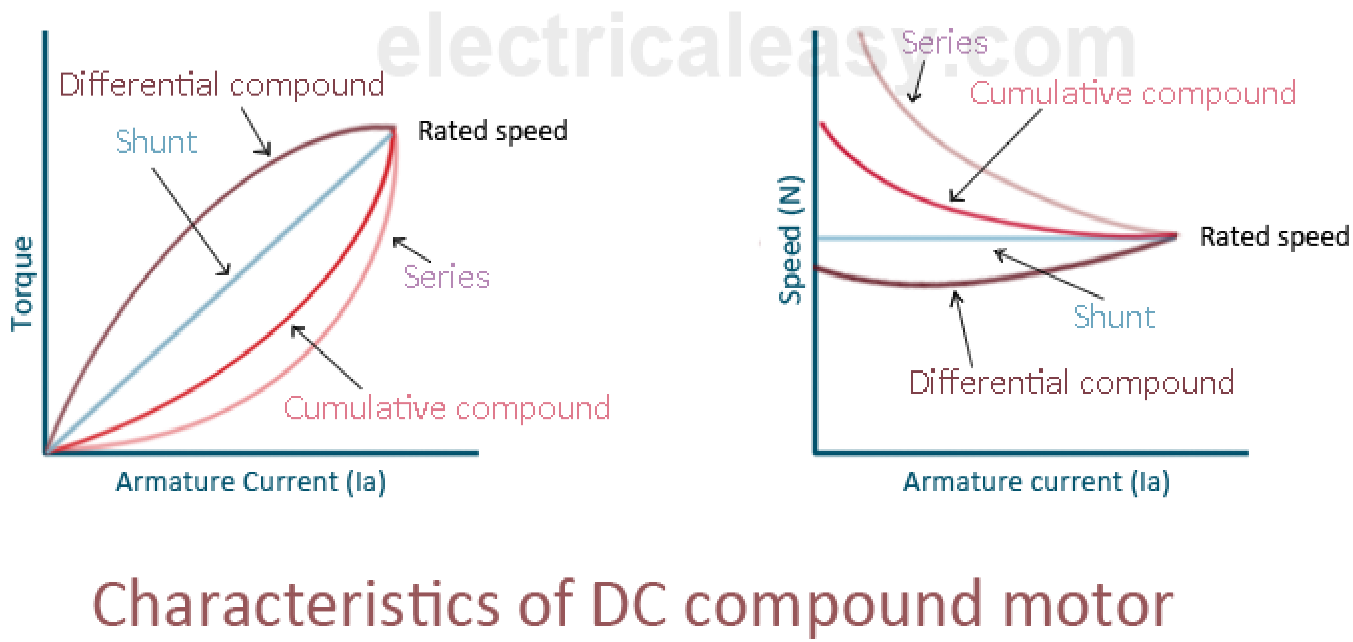
Characteristics of DC shunt motors :

In case of DC shunt motors, we can assume the field flux ϕ to be constant. Though at heavy loads, ϕ decreases in a small amount due to increased armature reaction. As we are neglecting the change in the flux ϕ, we can say that torque is proportional to armature current. Hence, the Ta-Ia characteristic for a dc shunt motor will be a straight line through the origin.



Characteristics of DC shunt motor

Here, series flux opposes shunt flux, the total flux decreases with increase in load. Due to this, the speed remains almost constant or even it may increase slightly with increase in load (N ∝ Eb/ϕ). Differential compound motors are not commonly used, but they find limited applications in experimental and research work.
characteristics of dc compound motor .



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SAVE YOUR FAMILY .
SAVE YOUR COUNTRY .
BE CONSCIOUS TO PREVENT COVID-19.