SNS COLLEGE OF TECHNOLOGY

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COIMBATORE-35

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME: 23EEB210 / Electrical Machines and Drives

II YEAR / IV SEMESTER

Unit II – ELEC4TRICAL MOTORS

Topic : Speed control methods of DC motor

Speed control methods of DC motor

Speed of a DC motor

Back emf Eb of a DC motor is nothing but the induced emf in armature conductors due to rotation of the armature in magnetic field. Thus, the magnitude of Eb can be given by EMF equation of a DC generator.

$Eb = P\Phi NZ/60A$

(where, P = no. of poles, Ø = flux/pole, N = speed in rpm, Z = no. of armature conductors, A = parallel paths)

Eb can also be given as,

$Eb = V - IaRa$

thus, from the above equations

$N = Eb\ 60A/P\Phi Z$

but, for a DC motor A, P and Z are constants

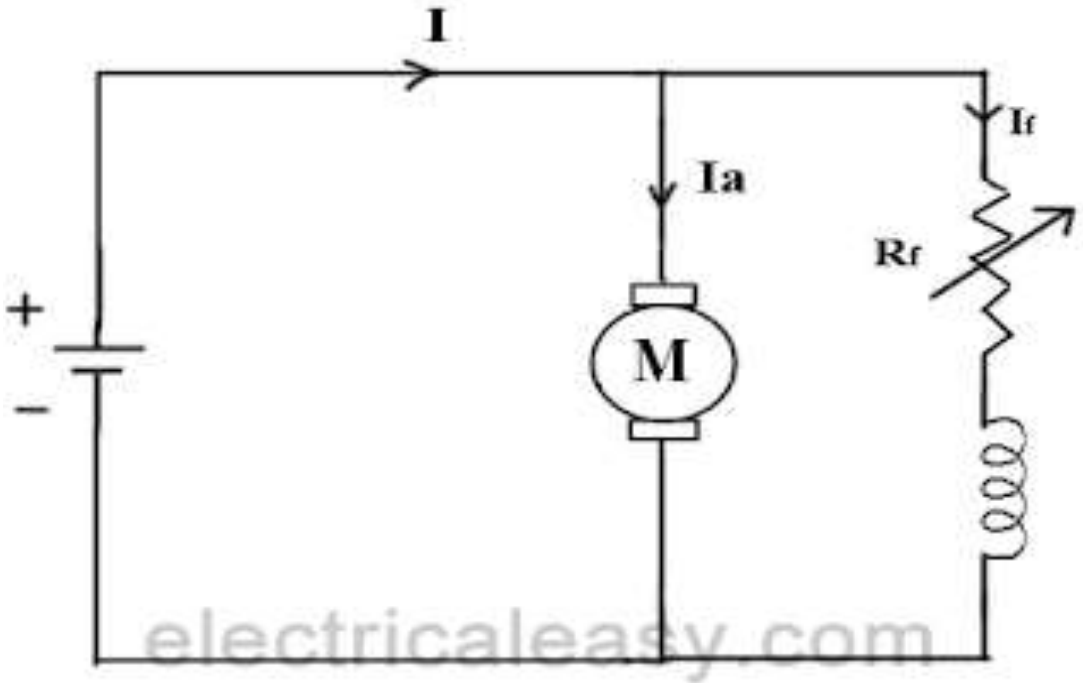
Therefore, $N \propto K\ Eb/\Phi$ (where, K=constant)

This shows the speed of a dc motor is directly proportional to the back emf and inversely proportional to the flux per pole.

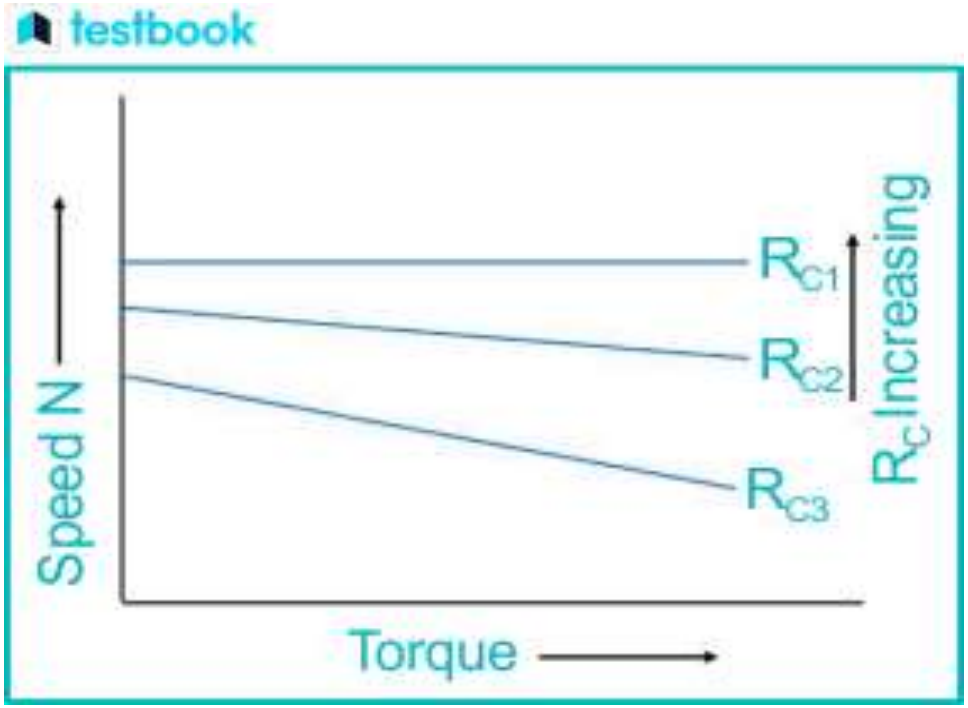
Flux control method

- It is already explained above that the **speed of a dc motor** is inversely proportional to the flux per pole.
- Thus by decreasing the flux, speed can be increased and vice versa.
- To control the flux, a rheostat is added in series with the field winding, as shown in the circuit diagram.
- Adding more resistance in series with the field winding will increase the speed as it decreases the flux.
- In shunt motors, as field current is relatively very small, I_{sh}^2R loss is small. Therefore, this method is quite efficient.
- Though speed can be increased above the rated value by reducing flux with this method, it puts a limit to maximum speed as weakening of field flux beyond a limit will adversely affect the commutation.

Flux control method diagram



The speed-torque curve for shunt motor



Speed control methods of DC motor

Advantages:

•Simple to implement.

•Provides a wide range of speed control.

Disadvantages:

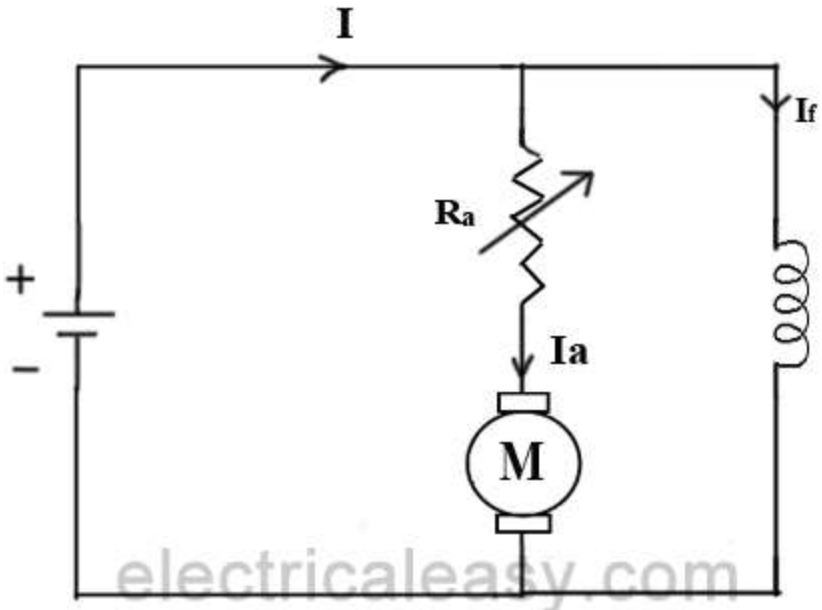
•Reduced torque at higher speeds.

•Field weakening can lead to instability.

Armature control method

- **Speed of a dc motor** is directly proportional to the back emf E_b and $E_b = V - I_aR_a$. That means, when supply voltage V and the armature resistance R_a are kept constant, then the speed is directly proportional to armature current I_a.
- Thus, if we add resistance in series with the armature, I_a decreases and, hence, the speed also decreases.
- Greater the resistance in series with the armature, greater the decrease in speed.

Armature control method Diagram



Armature control method

Advantages:

•Provides smooth and precise speed control.

•Maintains good speed regulation.

Disadvantages:

•Requires a variable voltage source.

•Limited to a specific speed range.

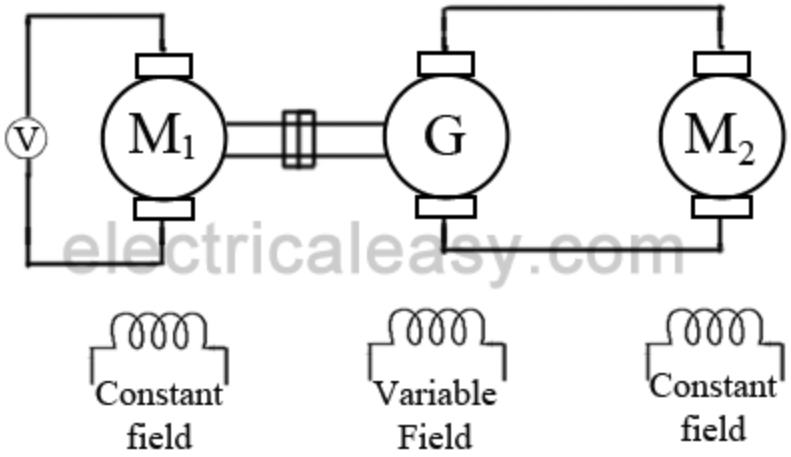
Voltage Control Method

- In this method, the shunt field is connected to a fixed exciting voltage and armature is supplied with different voltages. Voltage across armature is changed with the help of suitable switchgear.
- The speed is approximately proportional to the voltage across the armature.

Ward-Leonard System

- This system is used where very sensitive **speed control of motor** is required (e.g electric excavators, elevators etc.).
- The arrangement of this system is as shown in the figure at right. M_2 is the motor to which speed control is required.
- M1 may be any AC motor or DC motor with constant speed.
- G is a generator directly coupled to M1.
- In this method, the output from generator G is fed to the armature of the motor M2 whose speed is to be controlled.
- The output voltage of generator G can be varied from zero to its maximum value by means of its field regulator and, hence, the armature voltage of the motor M2 is varied very smoothly.
- Hence, very smooth speed control of the dc motor can be obtained by this method.

Ward-Leonard System diagram



Ward-Leonard System

Advantages of Ward-Leonard Drives

The main advantages of the Ward Leonard drive are as follows:

- Smooth speed control of DC motors over a wide range in both directions is possible.
- It has an inherent braking capacity.
- Using an overexcited synchronous motor as the drive compensates for the lagging reactive volt-amperes, thereby improving the overall power factor.
- For intermittent loads, such as in rolling mills, an induction motor with a flywheel is used as the drive motor. This configuration helps to smooth out intermittent loading to a lower value.

Ward-Leonard System

Disadvantages of Ward-Leonard Drives

The Ward Leonard system with rotating Motor Generator sets has the following drawbacks:

- High initial cost due to the installation of a motor-generator set with the same rating as the main DC motor.
- Larger size and weight.
- Requires a large floor area.
- Expensive foundation requirements.
- Frequent maintenance.
- Higher losses.
- Lower efficiency.
- Increased noise production.