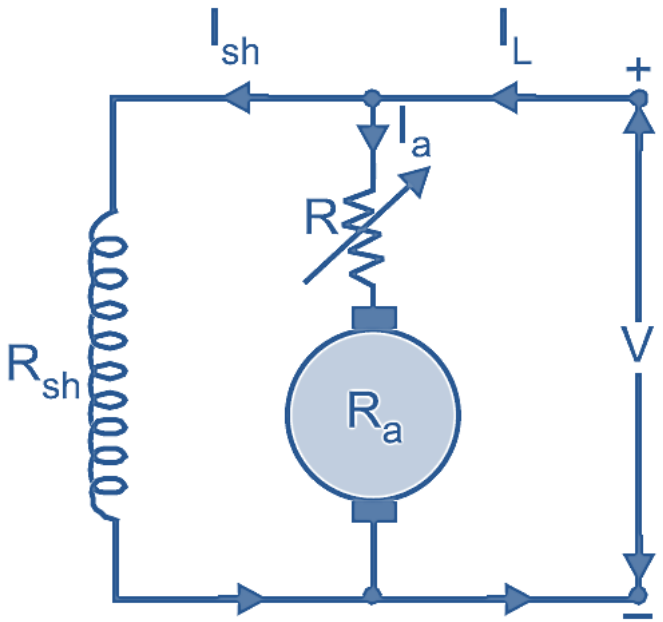
DC Motor Speed Control

Methods for controlling DC Motor Speed

- There are 3 main methods for controlling the speed of a dc motor:
- Armature Resistance Control
- Field Flux Control (Field Weakening)
- Armature Voltage Control

Armature Resistance Control

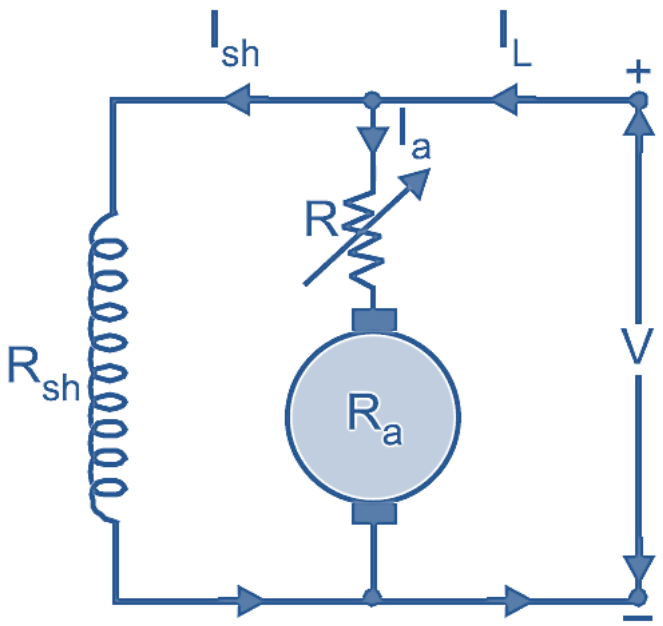
- Speed of a DC motor is directly proportional to back emf (E_6)
- Back emf equation: $E_6 = V - I_aR_a$ (where V = supply voltage, I_a = armature current, R_a = armature resistance).
- If V and R_a are constant, speed is directly proportional to I_a.
- Increasing resistance in series with the armature reduces I_a.
- Reduced I_a leads to decreased speed.



Advantages of Armature Resistance Control

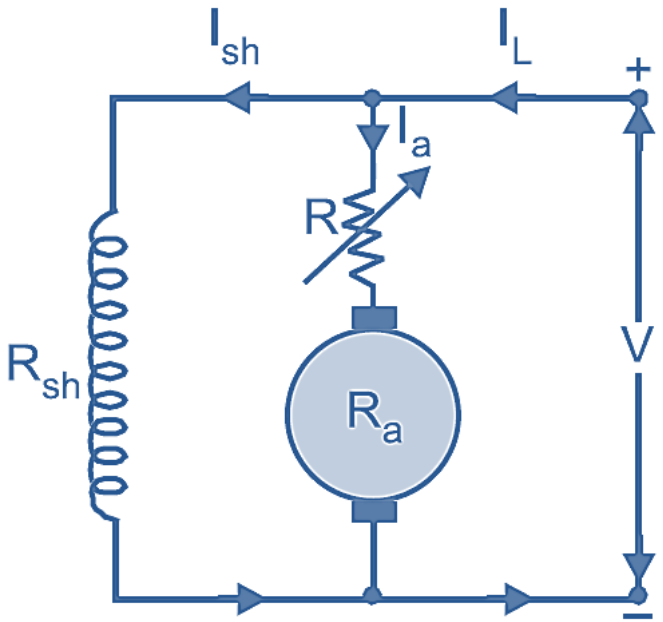
- **Constant field current and torque:** With the armature control method, the field current and torque levels remain constant throughout the application. Regardless of the speed of the motor, you can rely on these factors.

- **Fast and simple speed variation:** Armature controlled DC motors are known for their exceptional speed control, which allows operators to vary the speed as necessary in both directions.



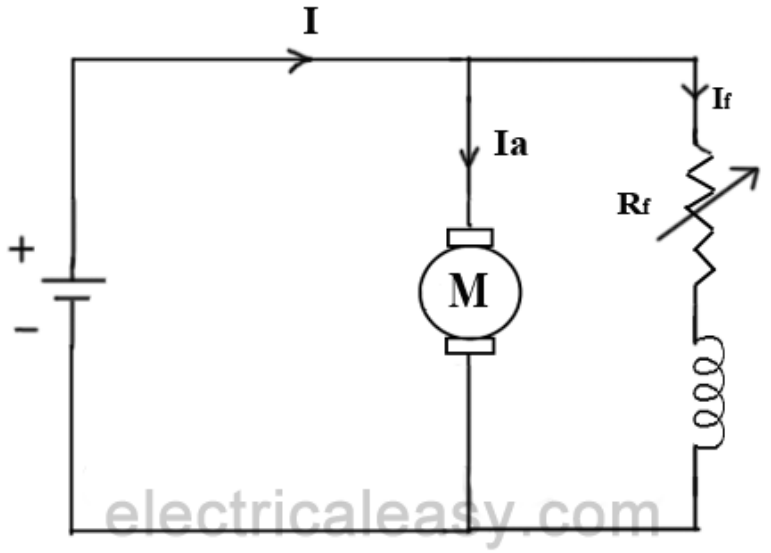
Disadvantages of Armature Resistance Control

- **Higher initial costs:** The armature control method is often more expensive than the field control method.
- **Low energy efficiency:** Armature control is most used for shorter lengths of time one reason is that speed variation tends to waste large amounts of power. This power loss makes the process less energy efficient and more costly overall.



Field Flux Control

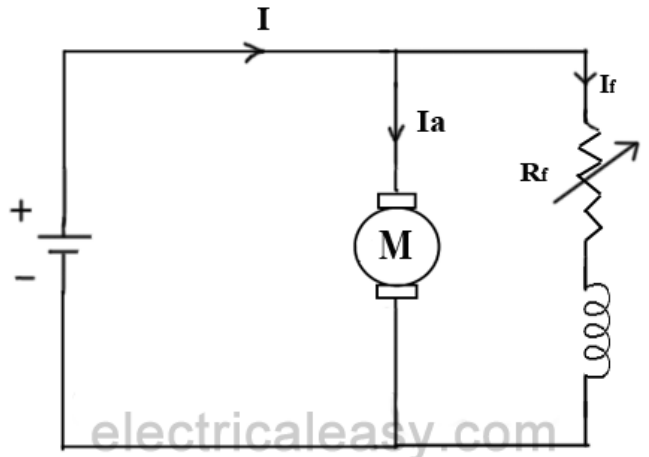
- Speed is controlled by varying the current in the field winding, thus changing the magnetic flux.
- Effective for speeds above the rated speed.
- Reducing field strength increases speed but reduces torque.



Advantages of Field Control

- **Lower costs:** The field control method is a highly economical form of motor control. It's easy to use and manage, and the lower operational costs make it cost-effective in the long-term. For manufacturers or engineers on a tight budget, this is an ideal solution.

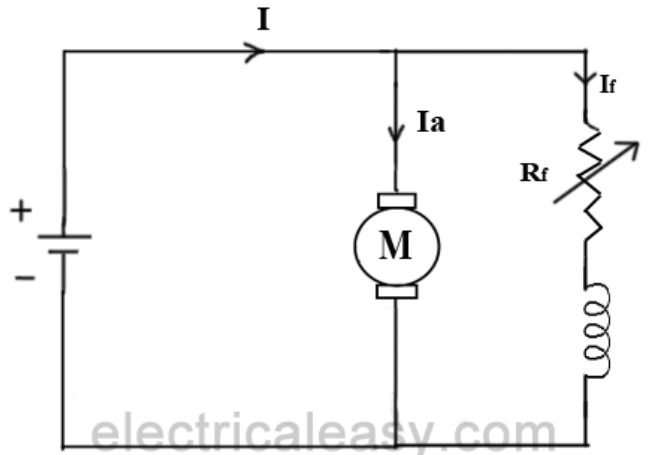
- **Minimal power loss:** The speed of a field-controlled DC motor is varied through the magnetic field rather than the armature. As a result, this method typically wastes a smaller amount of power. Extra energy efficiency can save both time and money while helping the environment.



Disadvantages of Field Control

- **Limits on speed:** If your application requires you to adjust the motor below the normal speed, you may be better off choosing an armature-controlled method. Field controlled DC motors can only operate above the normal speed. Higher speeds can also result in less torque.

- **Reduced stability**: The field control method allows operators to obtain higher speeds than the norm. Yet its overall range can be lowered due to a lack of stability. With a weaker field, you may only be able to safely exceed certain speeds.



Armature Voltage Control

- Speed is controlled by varying the voltage applied to the armature while keeping the field current constant.
- This is often done by using two different voltage sources, 1 for the stator and 1 for the rotor
- Effective for speeds below the rated speed.
- Common in industrial applications using thyristor-based or PWM converters.