

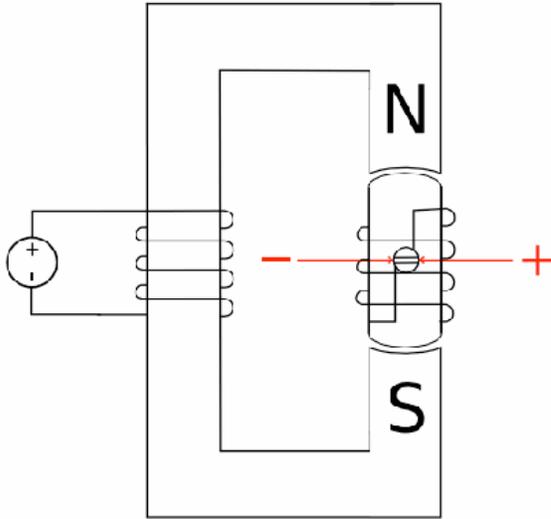
# 14. DC Motors (Chapter 11) – NOTES

## TOPIC 1: How a DC Motor Works

The three laws of magnetism

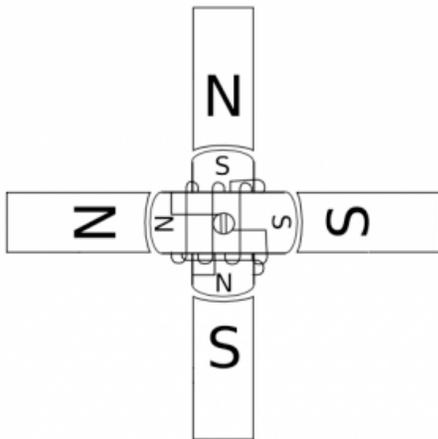
1. Like poles repel
2. Unlike poles attract
3. As the distance between the poles decreases the force increases

A DC motor works just the opposite of the DC Generator.



## TOPIC 2: Usable DC Motor

With one single pair of poles as shown above the torque is very uneven and causes cogging, or a pulsing of the mechanical power to the load. A usable DC motor has multiple pole pairs for more torque and less cogging. These poles are separated around the shaft. For example if a set of poles was added to the above simulation they would be shifted 90 degrees as pictured below.



DC Motor with 4 poles

### TOPIC 3: DC Motor Wiring

1. Separately Excited – Often times these include permanent magnets in place of the field winding.
2. Shunt – Achieves a constant speed under load.
3. Series – Achieves a high torque under load but cannot be run without a load or the motor will continue to increase in speed until it explodes.
4. Compound – Can achieve the benefits of both types of windings.

### TOPIC 4: Counter EMF and Motor Starting

The DC motor is identical to the DC generator so when the armature spins it generates a voltage in opposition to the power supply voltage called counter-electromotive force (CEMF). This CEMF increases as the speed increases and is zero when the speed of the machine is zero. This yields a very high initial current and can actually damage the motor at startup. Therefore, a special starter is required.

1. Sometimes a resistor in series with the armature winding is used to limit the current it is then removed when the speed has increased beyond a certain level.
2. Commonly an automatic starter with current sensing devices that automatically short out resistors are used.
3. Voltage can also be slowly increased in stages and finally switched to the final operating voltage when the speed has increased past a certain level.

You should now be prepared to answer the following questions.

1. Like poles \_\_\_\_\_.
2. As like or unlike poles get closer to one another the force they experience \_\_\_\_.
3. True or False? During rotation the current through the armature drops to zero.
4. True or False? During operation the magnetic field changes in the field winding.
5. Generally, as the number of poles in a motor increases the \_\_\_\_\_ increases.
6. A separately excited DC motor has two power sources. If the armature is powered by a DC power supply, the magnetic field in the stator is supplied by a DC power source supplying current to a field winding or by a(n)\_\_\_\_\_.
7. At zero speed, the CEMF is \_\_\_\_\_.
8. A DC motor starter is used to\_\_\_\_\_.