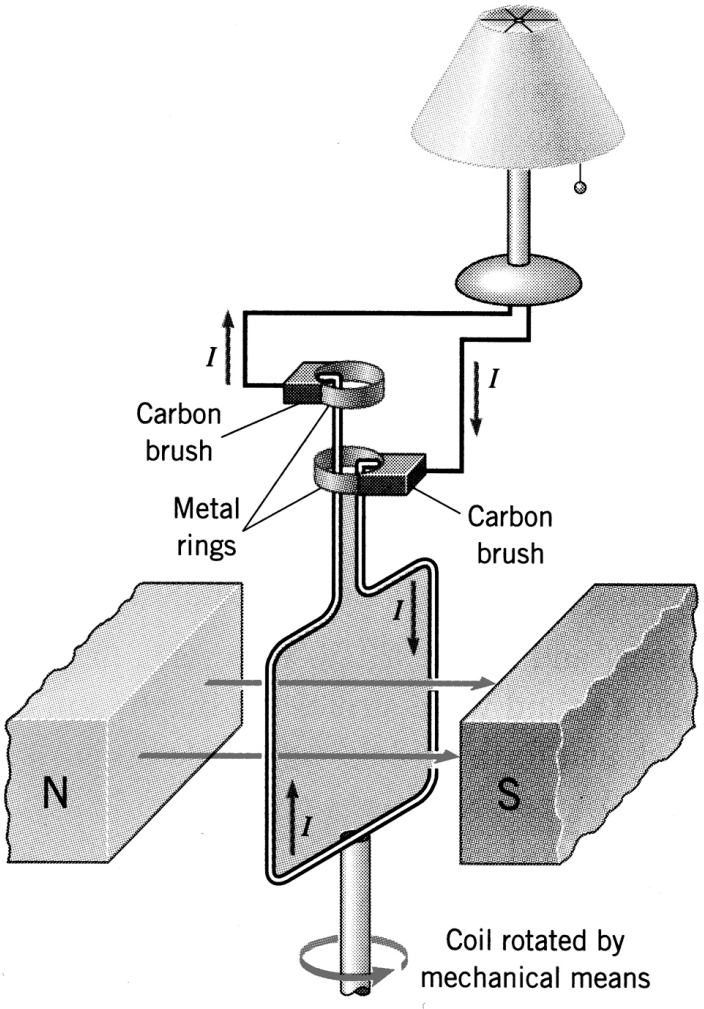
Generators and Alternating Current

A **generator** produces electrical energy from mechanical energy. In a generator, a shaft is rotated by some mechanical means, such as an engine or a turbine, and a voltage is induced in a coil. If the generator is connected to an external circuit, an electric current is output by the generator.

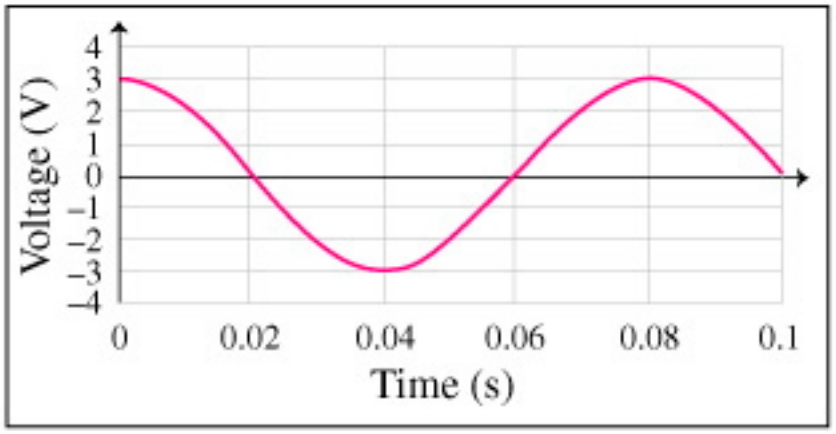
In its simplest form, an electric generator consists of a coil of wire that is rotated in a uniform magnetic field, as shown below.



Although not shown in the diagram, the wire is usually wound around an iron core. The coil/core combination is called the **armature**. Each end of the wire forming the coil is connected to the external circuit by means of a metal ring that rotates with the coil. Each ring slides against a stationary carbon brush, to which the external circuit is connected.

As the coil rotates within the magnetic field, the flux through the coil is constantly changing. This changing flux results in an induced voltage in the coil. Thus, current flows around the loop.

It is important to note that, for exactly half of one rotation, the flux through the coil is increasing, while for the other half of one rotation, the flux is decreasing. Thus, the voltage in the coil changes polarity as the coil rotates. The diagram below shows that the voltage varies as a sinusoidal function.



The result of this is that, for half of the rotation, the current in the loop flows clockwise, while for the other half it flows counterclockwise. This is referred to as **alternating current** or simply **AC**.

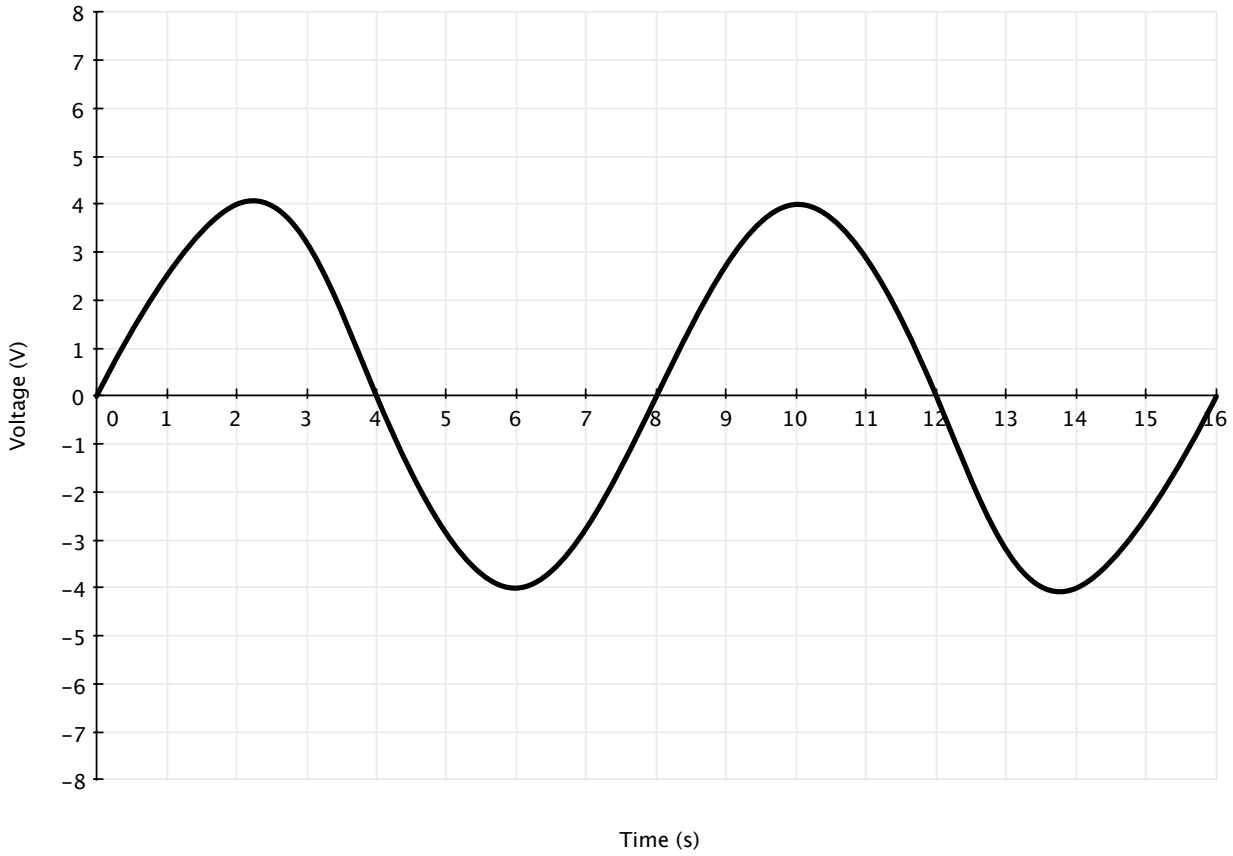
If the external circuit connected to the generator is a closed circuit, an alternating current results that changes direction at the same frequency as the voltage changes polarity. Therefore, this electric generator is called an **alternating current (AC) generator**.

Note: Despite the appearance of the above graph, the armature rotates so fast that the voltage produced is essentially constant. The generator represented by the above graph, for example, is producing a peak voltage of 3 V.

The amount of voltage produced by an AC generator can be changed by:

1. Rotating the coil at a different speed.
    - rotating faster will produce a larger voltage (twice as fast will result in twice as much voltage)
2. Changing the number of loops in the coil.
    - more loops will result in a larger voltage (twice as many loops will result in twice as much voltage)
3. Changing the area of the loops in the coil.
    - a larger coil will produce a larger voltage

Example
The graph below shows the output of an electric generator versus time.



If the generator's armature is rotated half as fast, sketch the new output of the generator on the same axes.