AC stands for **Alternating Current** as opposed to **DC, Direct Current**. AC refers to voltages and currents that change with time, usually the voltage is + sometimes and - at other times. This results in currents with go one direction when the voltage is + and the reverse direction when the voltage is -.

AC is important for two reasons. Power is created and distributed as AC. Signals are AC.

### AC Power

Power is generated by rotating magnetic fields. This naturally produces sinusoidal AC waveforms.

It is easier to make AC motors than DC motors.

### AC Power allows use of transformers to reduce line losses

Transformers work with AC, but not DC. Transformers can be used to raise or lower AC voltages (with an opposite change of current). This can be very useful in power distribution systems. Power is voltage times current. You can distribute the same amount of power with high voltage and low current as you can with low voltage and high current. However, the lower the current, the lower the $I^2R$ loses in the wires (all real wires have some resistance). So you’d like to distribute power at the highest possible voltage. Transformers allow you to do this with AC, but won’t work with DC.

Example:

**Without transformers**

$$
\text{Wire loss: } P_W = I_L^2 \cdot 2 \cdot R_w = 20 \text{ kW}
$$

**With transformers**

$$
\text{Wire loss: } P_W = I_w^2 \cdot 2 \cdot R_w = 2 \text{ W}
$$

In this example, the power lost in the transmission lines is only $1/10,000^{\text{th}}$ what it is without transformers. That’s why they raise the voltage in transmission lines to the point where they crackle and buzz. That crackle is the sound of the losses into the surrounding air and can become significant if the voltage is too high.
Signals
A time-varying voltage or current that carries information. If it varies in time, then it has an AC component.

In some unpredictable fashion
DC is not a signal. Neither is a pure sine wave. If you can predict it, what information can it provide?
Neither DC nor pure sine wave have any "bandwidth". In fact, no periodic waveform is a signal & no periodic waveform has bandwidth. You need bandwidth to transmit information.

Signal sources
Microphone
Audio
Camera
Video
Thermistor or other thermal sensor
Temperature
Potentiometer
Position
LVDT (Linear Variable Differential Transformer)
LVDT
Light sensor
Position
Computer
switch
etc...

Periodic waveforms: Waveshape repeats
\[ T = \text{Period} = \text{repeat time} \]
\[ f = \text{frequency, cycles / second} \quad f = \frac{1}{T} = \frac{\omega}{2\pi} \]
\[ \omega = \text{radian frequency, radians/sec} \quad \omega = 2\pi f \]
A = amplitude
DC = average

Sinusoidal AC
\[ y(t) = A \cdot \cos(\omega t + \phi) \]
Voltage: \[ v(t) = V_p \cdot \cos(\omega t + \phi) \]
Current: \[ i(t) = I_p \cdot \cos(\omega t + \phi) \]
Phase: \[ \phi = \frac{\Delta t}{T} \cdot 360 \text{-deg} \quad \text{or:} \quad \phi = \frac{\Delta t}{T} \cdot 2\pi \text{-rad} \]

Other common periodic waveforms
- Square
- Triangle
- Half-Rectified Sine wave
- Pulse
- Sawtooth
- Full-Rectified Sine wave

All but the square and triangle waves have a DC component as well as AC.