Transformers

What it is:

A piece of metal with two sets of electric coils (windings).
The coils can be interwoven or on different parts of the transformer.
The input coils are called the primary (first side).
The output coils are the secondary (second side).

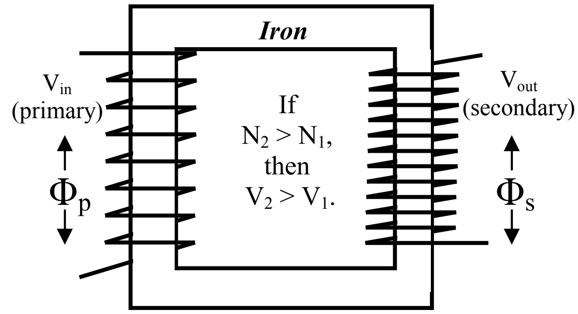
What it does:

Transforms one AC voltage to another.
The side with the most coils has the most voltage.
Step–up transformer: $V_1 < V_2$ (increases voltage)
$N_1 < N_2$ (secondary has move coils)
Step–down transformer: $V_1 > V_2$ (decreases voltage)
$N_1 > N_2$ (secondary has less coils)

How it works:

Changing I (current) makes changing B (magnetic field).
This changing B is called the magnetic flux (Φ).
The Φ in the primary (Φ_p) is transferred to the secondary via the metal casing.
For a very efficiently designed transformer:
$\Phi_p = \Phi_s$ and $P_p = P_s$ (power).
Transformers work by Φ, so there must be a changing B, and a changing I: **transformers only work with AC current**!

A Step-Up Transformer:
Increasing V by Increasing N



The side with the most coils (N) will have the most voltage (V).

$\Phi_p = \Phi_s$
The Magnetic Flux is equal on both sides.

To make it a step-down transformer, apply voltage in reverse: to the right side. Since the left side has more coils ($N_1 > N_2$) the induced voltage (on the left) will be less: $V_1 > V_2$.

***Primary*: the side you put V in.**
***Secondary*: the side you are getting V out.**

You put voltage on the primary to transform it to a different voltage at the secondary.

VARIABLES DEFINED:

"p" stands for the primary or side in.
"s" stands for the secondary or side out.
V – voltage; N – number of coils.
V_p is the voltage of the primary (V_{in}).
V_s is the voltage of the secondary (V_{out}).
N_p is the number of coils in the primary.
N_s is the number of coils in the secondary.

How the Math Works:

Faraday's Law of induction: $emf = -N\dfrac{\Delta[AB(\cos\theta)]}{\Delta t}$

The magnetic flux (Φ) is defined as $= \Delta[AB(\cos\theta)]$

So, $V = -N\dfrac{\Phi}{\Delta t}$. Solving for Φ, $\Phi = \dfrac{V\Delta t}{-N}$.

In a transformer: $\Phi_p = \Phi_s$, so $\dfrac{V_p\Delta t_p}{-N_p} = \dfrac{V_s\Delta t_s}{-N_s}$.

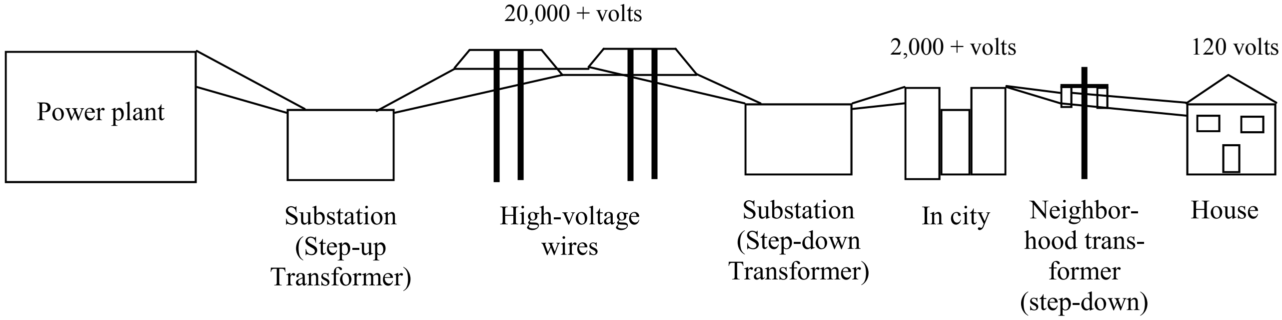
Since it happens in real time: $\Delta t_p = \Delta t_s$.

So in a transformer, $\dfrac{V_p}{V_s} = \dfrac{N_p}{N_s}$ OR $\dfrac{V_p}{N_p} = \dfrac{V_s}{N_s}$

Also, $P_p = P_s$ So, $V_pI_p = V_sI_s$.

If you increase the voltage, you decrease the current.

Transformer Equations: $\dfrac{V_p}{V_s} = \dfrac{N_p}{N_s}$ and $V_pI_p = V_sI_s$



Electric Motors and Generators.

Electricity goes in to make electromagnetics, create a magnetic force, and motion (work out).

Motors can be reversed: put work in, get electricity out: that's a generator.

Usually there are permanent magnets on the motor housing that help push the center electromagnets (on the armature).

Commutator – keeps the electricity (and therefore B) in the correct coils at the correct time.
Looks like a circle with breaks in it.