

AC and DC

- ✓ **Direct current (DC)** flows one way; **alternating current (AC)** reverses direction over and over
- ✓ **Frequency:** AC cycles per second, in hertz; 60 Hz in the US, 50 Hz in Europe, Asia and Australia
- ✓ Power travels at **high voltage** because the same power then needs less current, and the loss is I^2R : half the current, a quarter of the loss
- ✓ Outlets supply AC; most electronics run on DC inside, through an adapter or power supply

From AC to DC

- ✓ **Diode:** lets current through one way only; diodes together turn AC into DC, **rectification**
- ✓ **Capacitor:** stores energy in an electric field, like a spring (farads); smooths the ripples left in rectified DC

Magnetism and induction

- ✓ Field lines run from a magnet's **north** pole around to its **south**
- ✓ Current in a wire makes a magnetic field; a coil carrying current is an **electromagnet**
- ✓ **Induction:** a conductor moving through a magnetic field, or a field changing around a conductor, makes a current: a magnet pushed through a coil
- ✓ **Inductor:** a coil that stores energy in its magnetic field and resists changes in current, like a flywheel (henries)

Transformers

- ✓ Two coils on one core: AC in the **primary** induces current in the **secondary**; AC only
- ✓ **Step-up** raises voltage, **step-down** lowers it: $\frac{V_s}{V_p} = \frac{N_s}{N_p}$, the ratio of the coils' turns
- ✓ Stepped up to travel long distances, stepped down for homes

Motors and generators

- ✓ **Motor:** electrical energy in, rotation out: a current-carrying coil spins in a magnetic field
- ✓ **Generator:** rotation in, electrical energy out, by induction
- ✓ The same device run in opposite directions; grid generators spin in step to keep one frequency

Semiconductors

- ✓ **N-type:** extra electrons, negative carriers; **P-type:** "holes", positive carriers
- ✓ **P-N junction:** where they meet, a **depletion region** with no free carriers forms
- ✓ **Diode:** one P-N junction
 - **Forward bias:** carriers pushed to the junction; current flows
 - **Reverse bias:** carriers pulled away; current blocked
- ✓ Diodes replaced **vacuum tubes:** no warm-up; smaller, cooler, longer-lasting and using less power
- ✓ **Transistor:** three layers, NPN or PNP, with a thin middle layer, the **base:** a small current there controls a large one, so it works as a **switch** or an **amplifier**
- ✓ A computer chip holds billions of transistors

Units

Quantity	Unit	Quantity	Unit
Voltage	Volt (V)	Capacitance	Farad (F)
Current	Amp (A)	Inductance	Henry (H)
Resistance	Ohm (Ω)	Frequency	Hertz (Hz)
Power	Watt (W)		