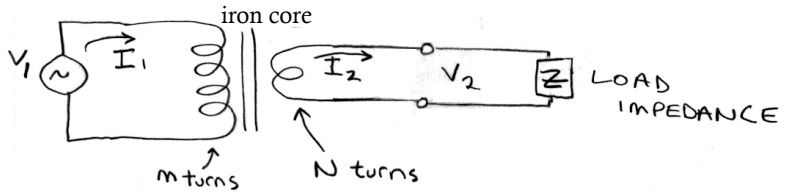
Transformer



POWER UNCHANGED, VERY EFFICIENT

$$V_1 I_1 = V_2 I_2$$

$$V_2 = \frac{N}{m} V_1$$

Voltages generally reported as RMS

- Permits efficient high voltage power transmission
- Westinghouse (Tesla) Pittsburgh
- 1900 World's Fair, Niagara Falls to Buffalo

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Any periodic signal at frequency ω_0
Can be written as a series of sinusoids

$$V(t) = \frac{A_0}{2} + \sum_{n=1}^{\infty} (A_n \cos n\omega_0 t + B_n \sin n\omega_0 t)$$

"D.C." Component

A_n are real coeficients
$n=1$ for "fundamental"
$n=2,3,$ etc for second, third, ... "harmonics"

$$= \sum_{n=-\infty}^{+\infty} a_n e^{jn\omega_0 t}$$

coeficient is now complex

negative frequencies to provide complex conjugates

Fourier Series

$\frac{A_0}{2}$ because it contains both conjugates at "DC", $\cos(0t)$.

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Non-Linear Circuits

- We have been talking about linear circuits
  - DC represented by Linear equations
  - AC represented by Linear *differential* equations
- Now we introduce non-linear circuits
  - Mathematical representation more complex
  - We describe their behavior in other ways
  - Simplifying assumptions actually make it easier
  - New capabilities including *gain* (amplification)

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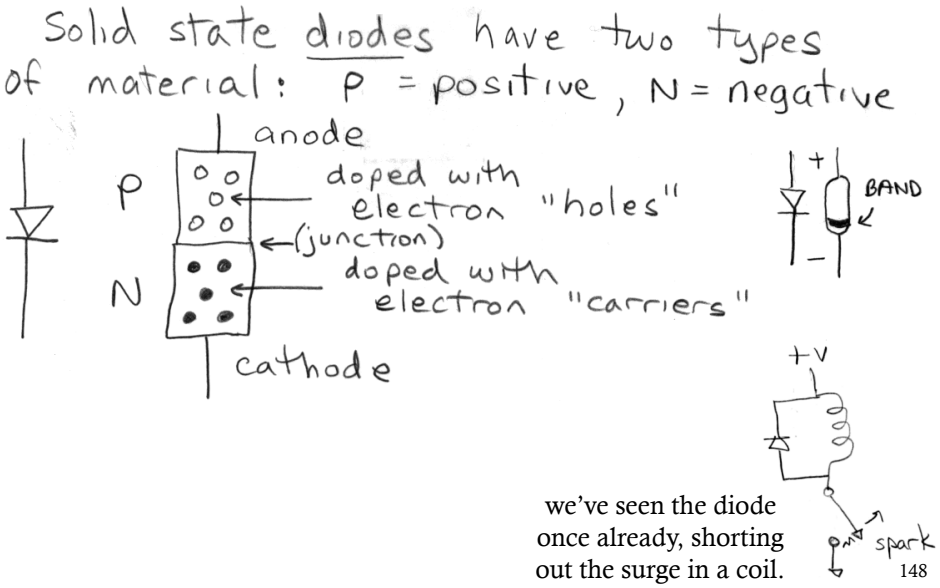
Diode



we've seen the diode once already, shorting out the surge in a coil.

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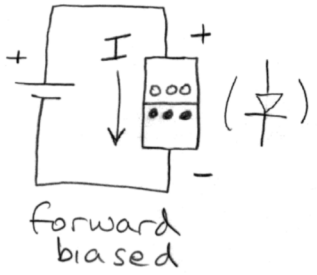
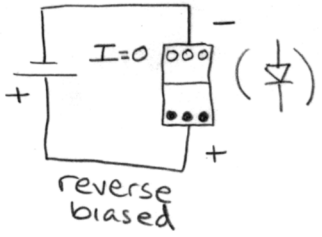
Diode acts as a one-way valve

when "forward baised" holes touch carriers at the junction and current flows.

when "reverse biased" holes do not touch carriers and current does not flow.





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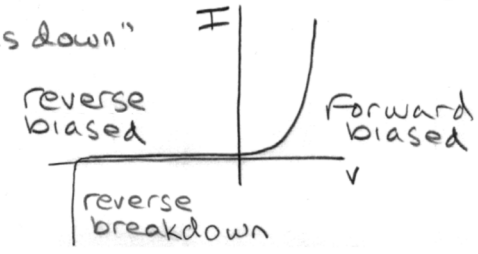
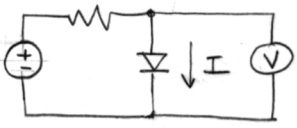
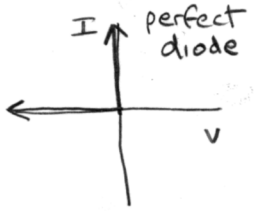
Graphical Representation on *V-I* Plane

The current is exponentially related to the voltage when forward biased. At sufficient reverse voltage diode "breaks down"







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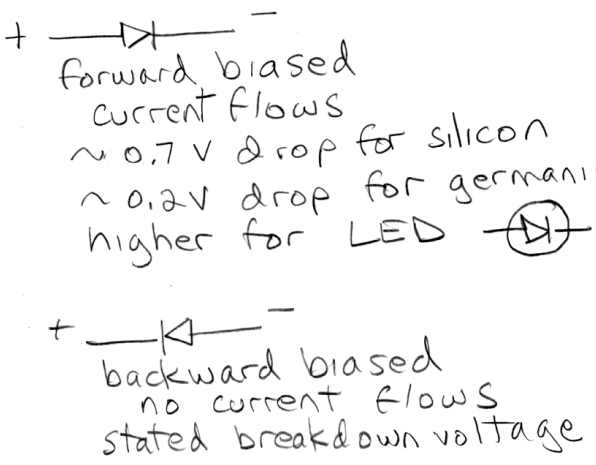

	hole (missing electron)	semiconductor (covalent bonds)	carrier (extra electron)
	5 B	6 C	7 N
	13 Al	14 Si	15 P
	31 Ga	32 Ge	33 As
Valance group	3	4	5

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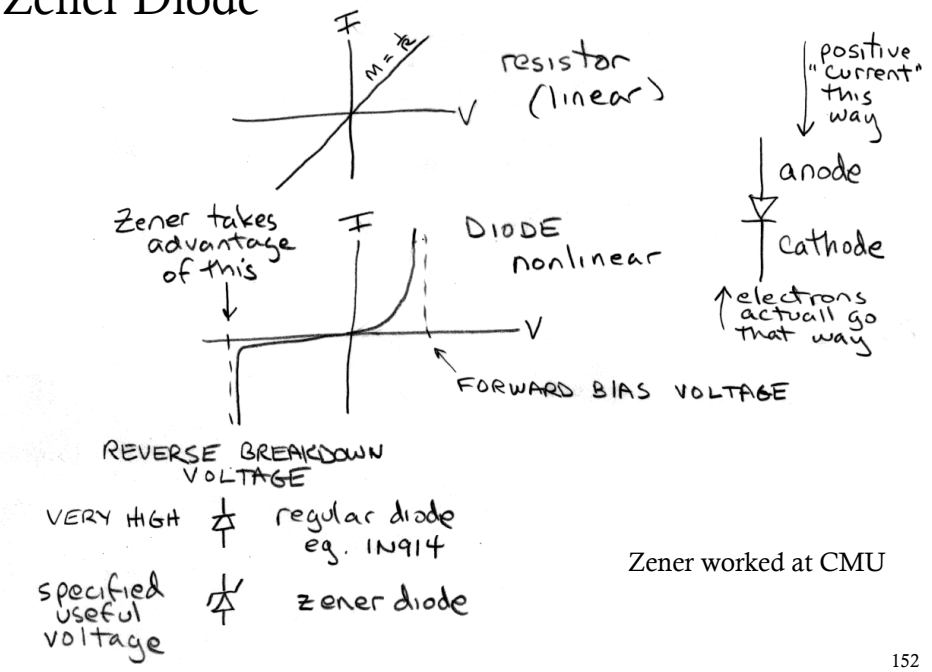
Zener Diode



Zener worked at CMU

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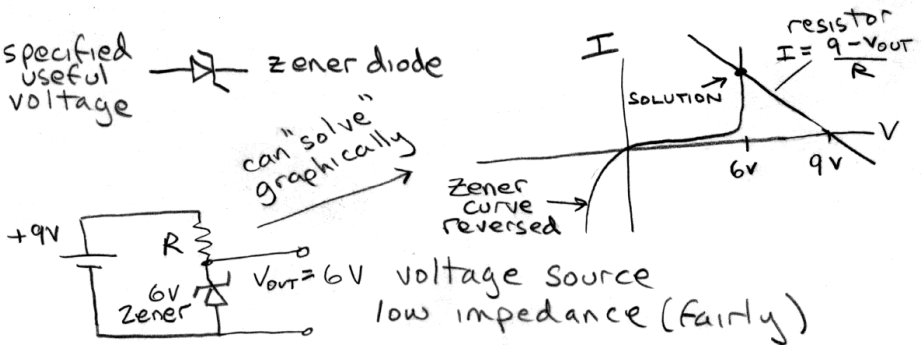
Can solve circuits graphically on *V-I* graph



- Zener points *into* the current and is purposefully *biased* in the reverse breakdown region.
- Like pressure regulator on a SCUBA tank.

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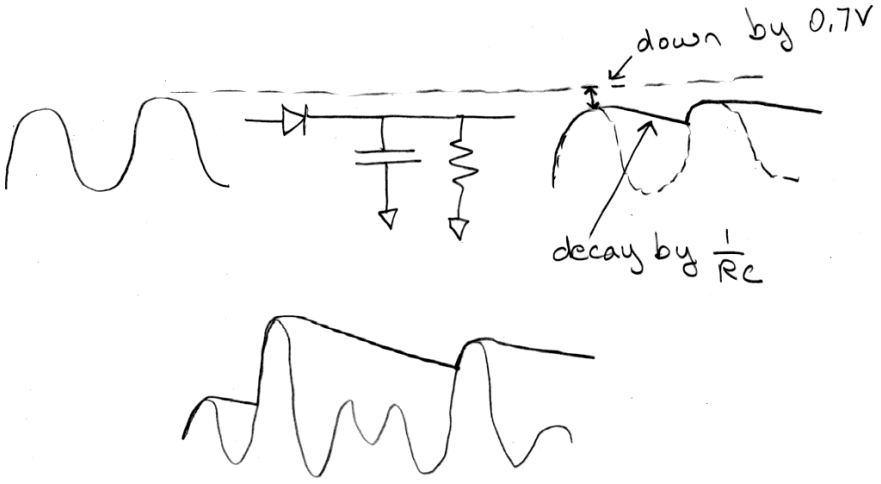
Diode as *Peak Detector*



- Keeps a running maximum
- Need resistor to "reset" peak detector
  - Otherwise it gives highest voltage since beginning of time

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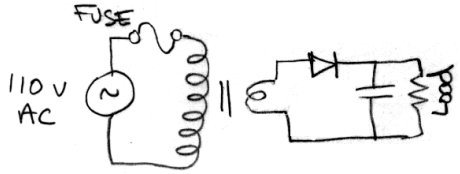
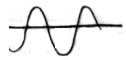
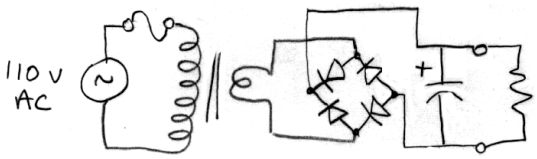
Rectification

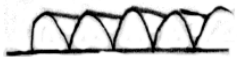
- Turns AC into DC
- Half-Wave Rectification





- Full-Wave Rectification





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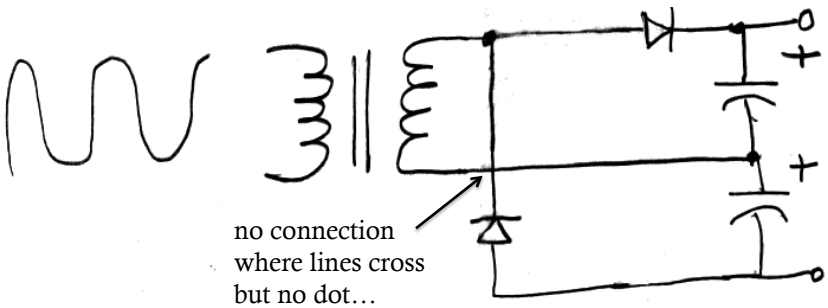
Voltage Doubler



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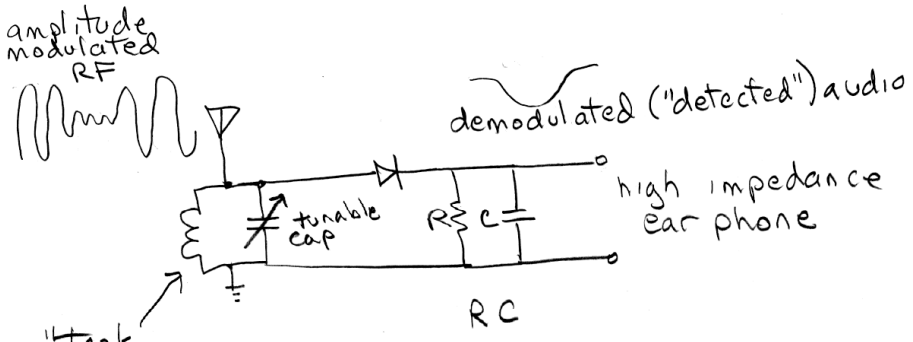
Amplitude Modulation (AM) radio receiver



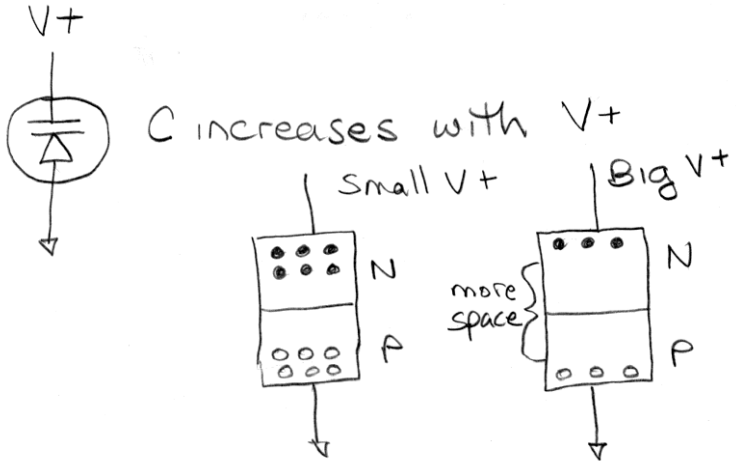
$Z = \infty$ at resonant freq.

system can be passive (no battery)

some people's dental cavities pick up radio stations

Invented by Reginald Fessenden, Chair EE U. Pitt. 157

Varactor (variable capacitor diode)



used to modulate RF (radio freq.) oscillators

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