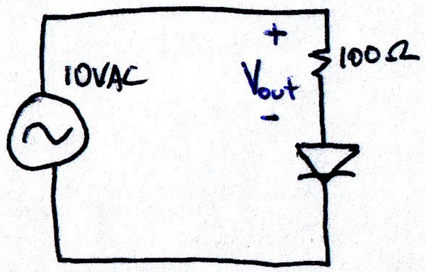
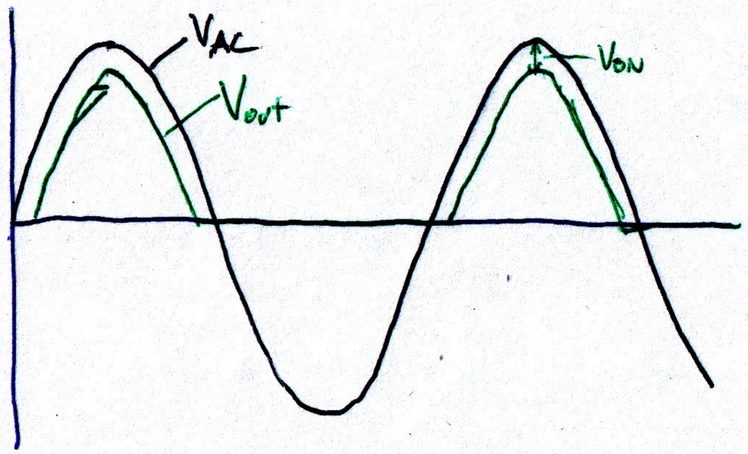
Diodes in AC Circuits

We've discussed how diodes can have discontinuous IV curves, at least in the models in our heads. We described these as DC, but diodes in practical applications can be treated as almost instantaneous.



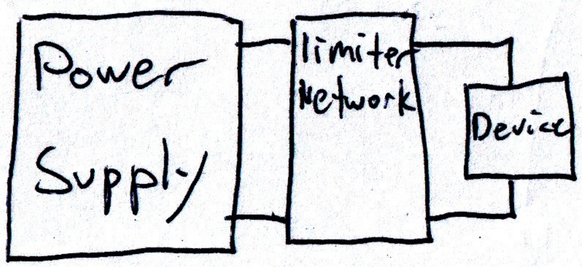
(Ignore the ON-Resistance of the diode.)

- For this circuit, the voltage across the resistor is an indicator of the current from the source. It will be zero whenever the turn-on voltage isn't met.

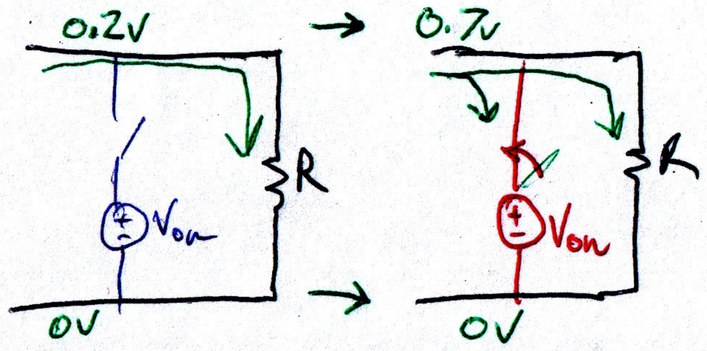


Limiters

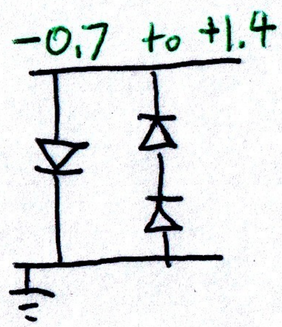
Basic idea: employ nonlinear circuits (diodes) to prevent a component or system from seeing too much voltage.

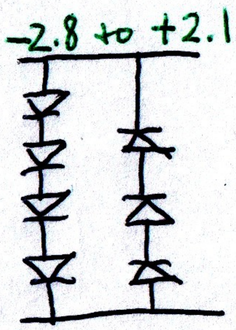


In these circuits, diodes act as switchable voltage sources, soaking up current that would otherwise drive a load too high.

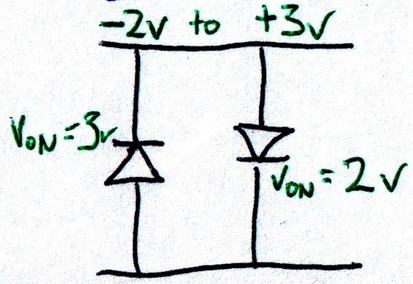


Complex networks of these can be used to hit various limit targets:





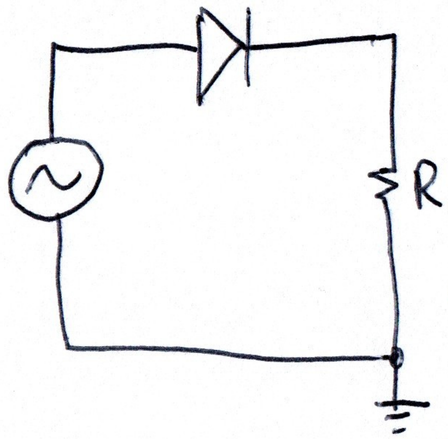
(and simpler networks can be made with diodes of varying V_{ON} to do the same jobs.)



AC to DC Conversion

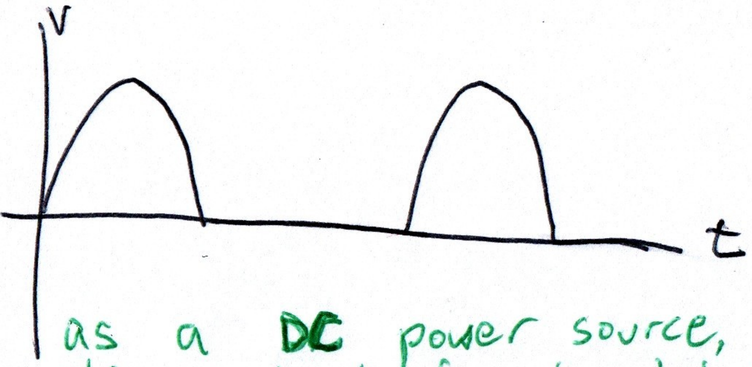
The first thing we need is a way to prevent negative voltages on the load.

This is called rectification. simple rectifiers are easy:



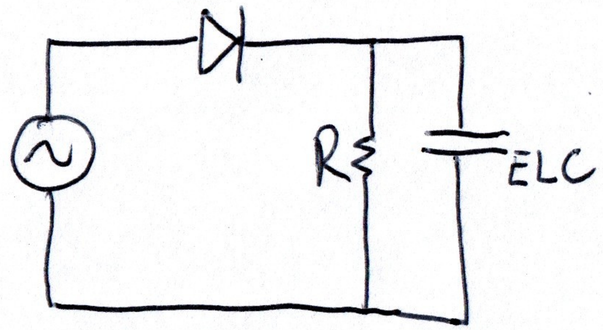
A "half-wave" rectifier

Output:



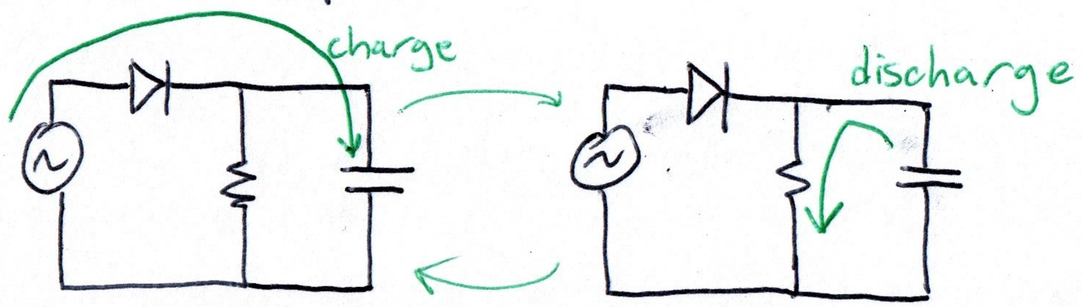
as a **DC** power source, this is kind of underwhelming.

Enter the Extremely Large Capacitor:

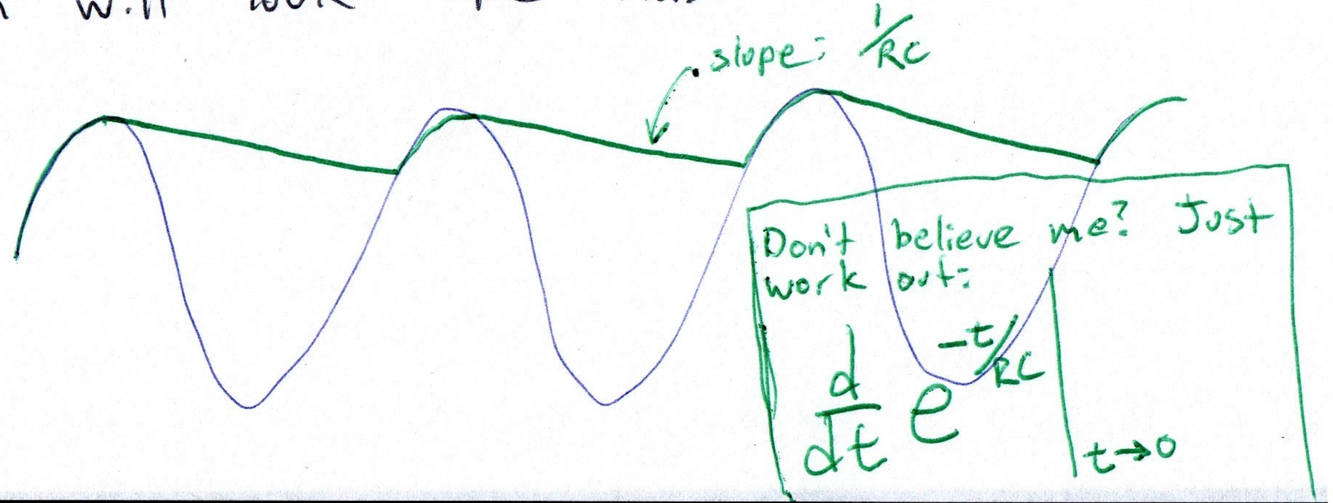


If the capacitor were actually infinite, it could power the load forever. However it would also take infinite energy to charge.

If the capacitor is very large, we get a DC output:

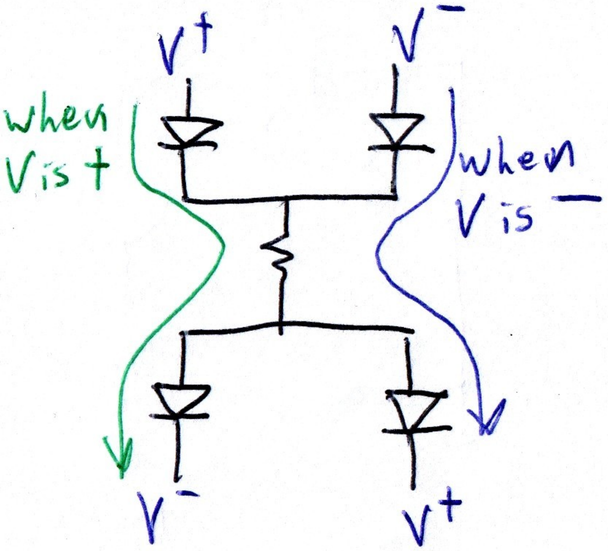


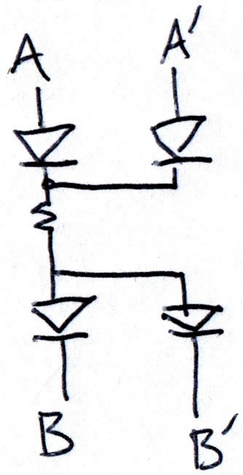
Now suppose the capacitor is finite. An unattended capacitor will drain as $e^{-t/RC}$. If it's reasonably large though, that drain will look like this:



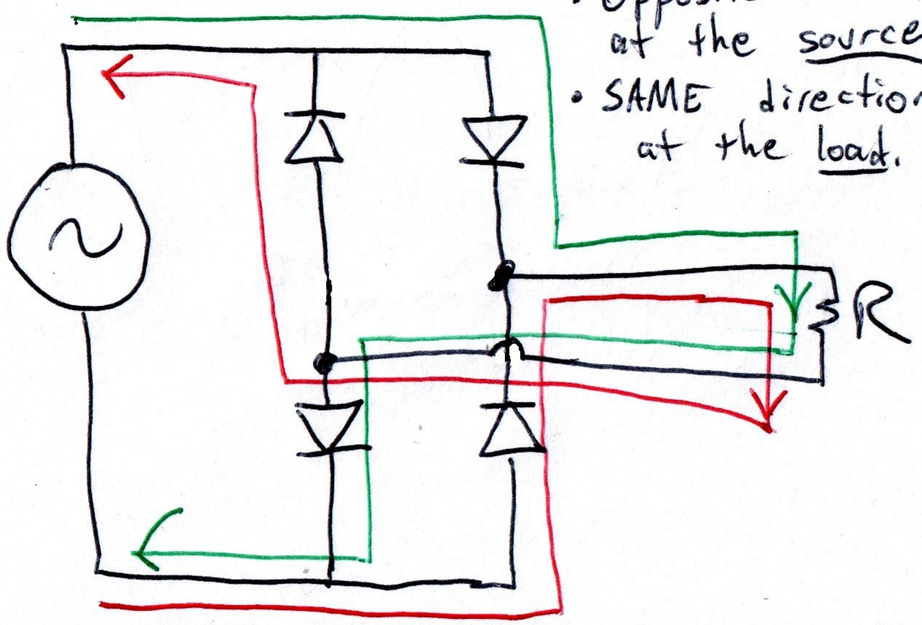
Crazy Concept: Full-Wave Rectification

The basic idea here is to have current take two paths: One for positive voltages, one for negative ones.



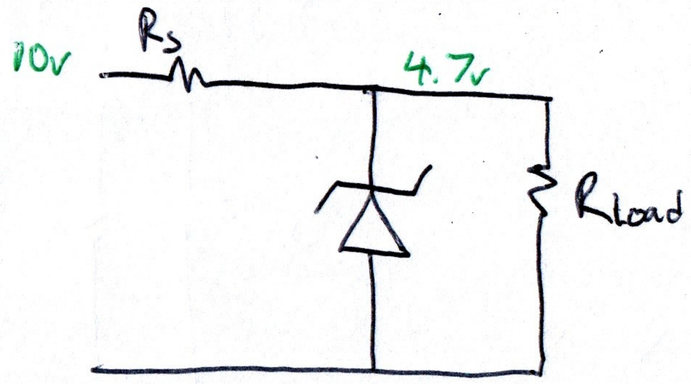


Both need to go through the load in the same direction, though.



- opposite directions at the source
- SAME direction at the load.

Last: Zener Diode Regulator



Ideally, the Zener diode will always be in reverse operation, acting like a voltage source. Of course, this uses some current, but nowhere near as much as an appropriately-sized voltage divider would. (It also holds its voltage over a range of load R)