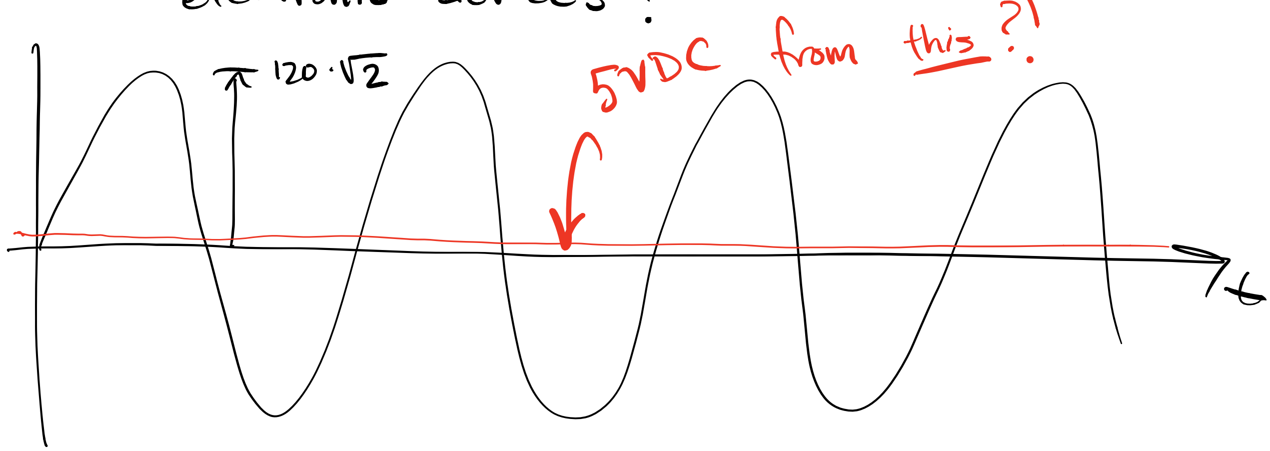
Rectification and Power Supplies

∴ linear power supply; not switching!

∴ how do you turn 120 V_{RMS} @ 60 Hz (sine) into, say, 5 VDC for powering small electronic devices?



1.) use stepdown transformer to scale magnitude of AC voltage into more reasonable range

2.) use rectifier to make sine wave all positive [for now]

∴ still not D.C.!

3.) use capacitors and/or inductors to "smooth" the waveform into something much closer to D.C.

4.) electronic voltage regulation will set precise voltage and make it almost perfect D.C.

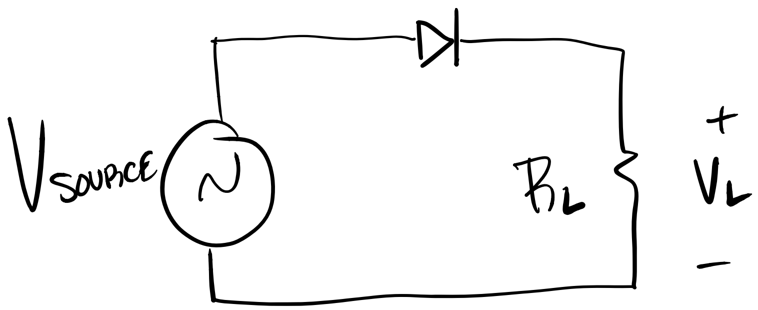
∴ in power supplies, transformers are specified with primary and secondary voltages not turns or turns ratio!

∴ secondary voltage specified at rated load current.

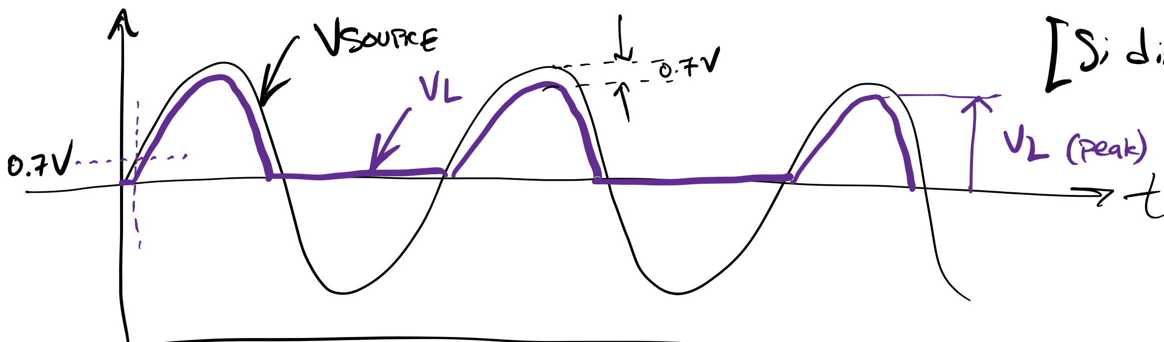
rectifiers

∴ used to convert AC sine wave into one-direction (positive) waveform

half-wave rectifier : simplest, requires no transformer



∴ diode becomes forward biased only when $V_{SOURCE} > \sim 0.7V$ [Si diode]



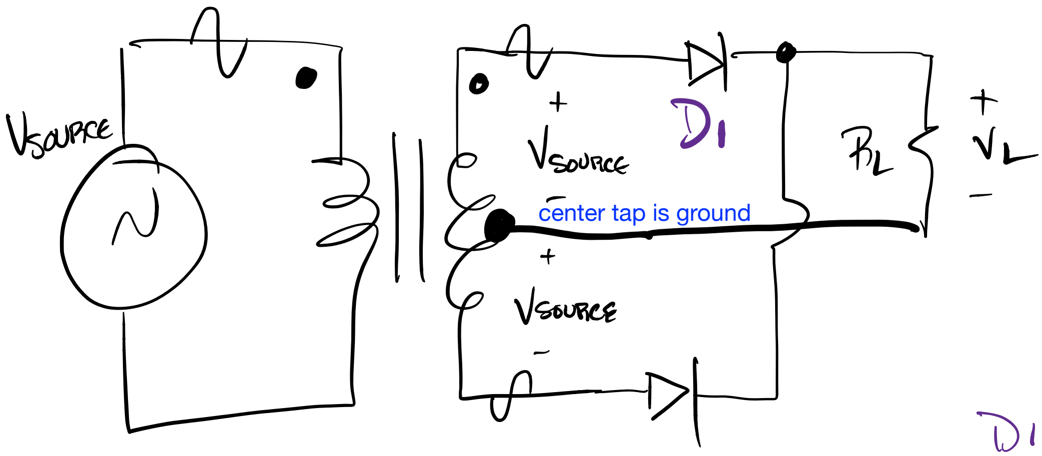
$$\boxed{V_{L\,(peak)} = V_{SOURCE\,(RMS)} \cdot \sqrt{2} - 0.7}$$

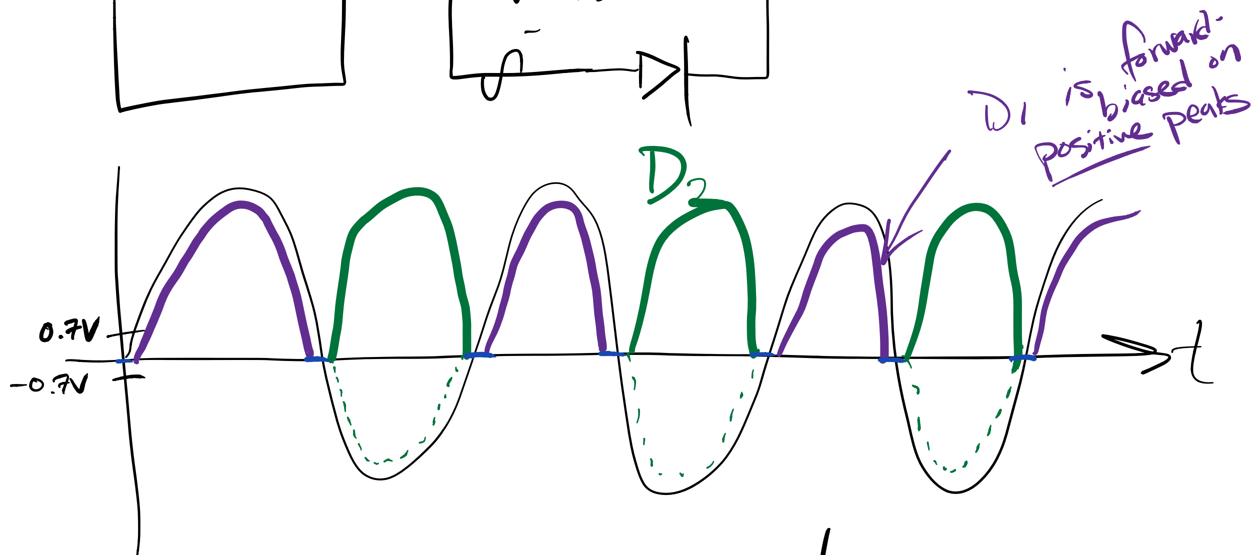
∴ one disadvantage of half-wave rectifier; negative peaks simply ignored

∴ we need a more efficient circuit!

center-tapped rectifier

∴ requires transformer secondary w/ center tap.





∴ full-wave rectification!

$$\boxed{V_{L\,(peak)} = \underbrace{V_{SOURCE\,(RMS)}}_{\text{one half of transformer secondary}} \sqrt{2} - 0.7}$$

↑ assuming si diode

∴ some transformer manufactures will state secondary voltage as, for example:

$$12 - 0 - 12 \quad V_{RMS} \; @ \; 2A$$

∴ most would state "24 VCT" for the same secondary

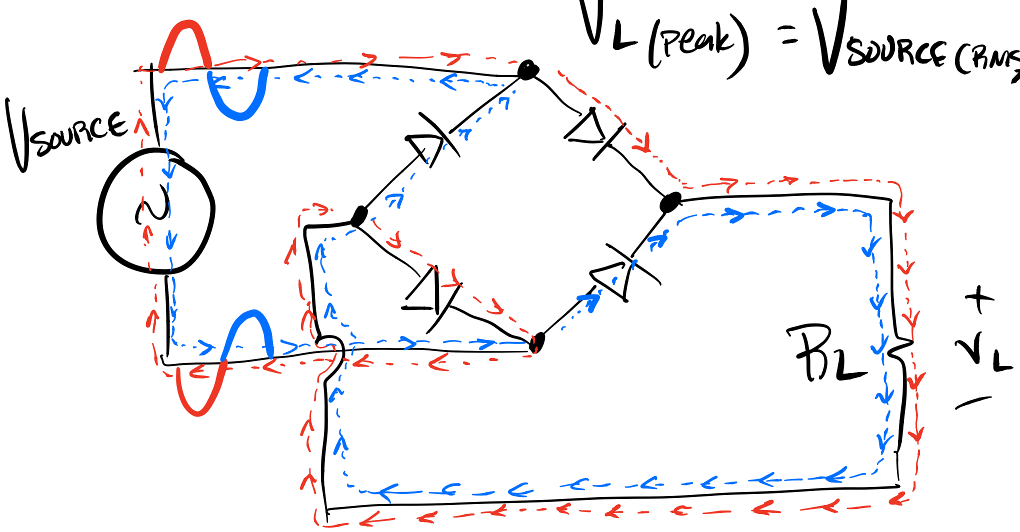
"center-tap"

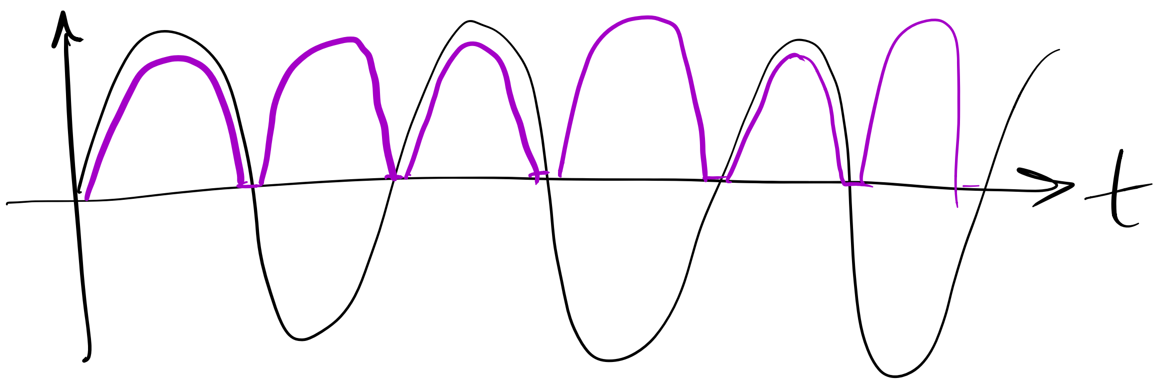
∴ regular secondary w/ no center tap: "24 VAC"

full-wave bridge rectifier

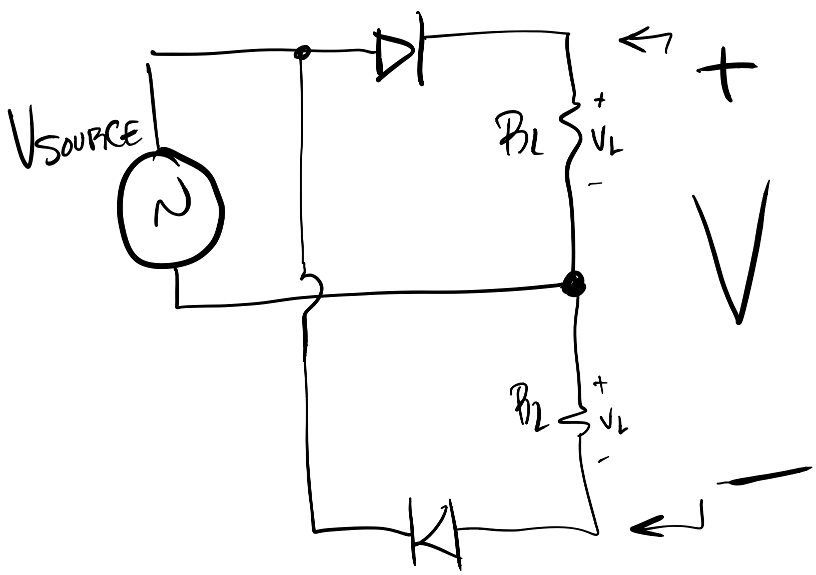
$$V_{L\,(peak)} = V_{SOURCE\,(RMS)}\sqrt{2} - 1.4$$

two diode drops!





Voltage doubler :



positive and negative half-wave rectifiers in series to double voltage

$$V_{peak} = 2 \cdot V_{SOURCE(RMS)} - \underbrace{2 \cdot 0.7}_{1.4V}$$

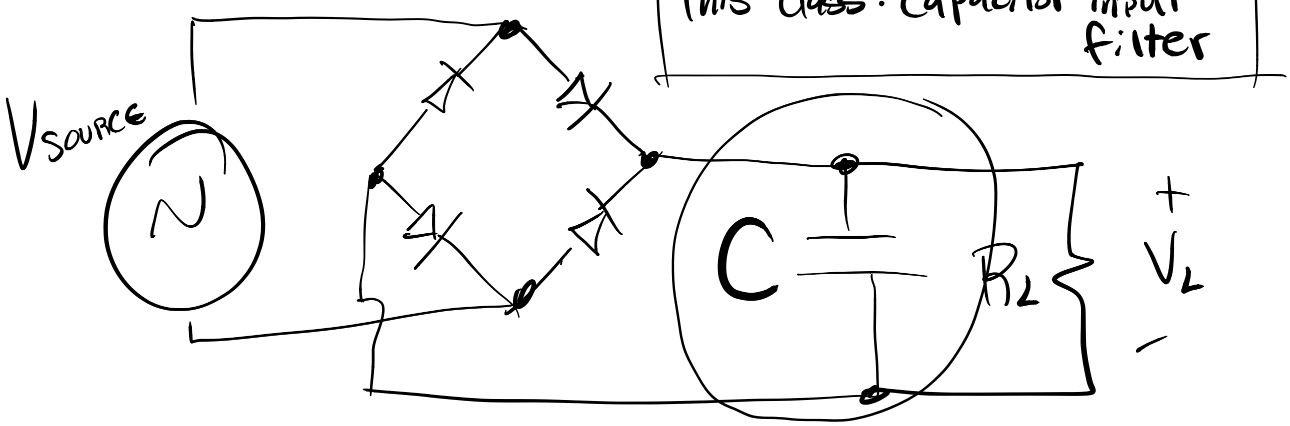
(two diode voltage drops)

∴ a full-wave rectified sine wave is equivalent to the absolute value of a sine wave

∴ how do we turn it into D.C.?

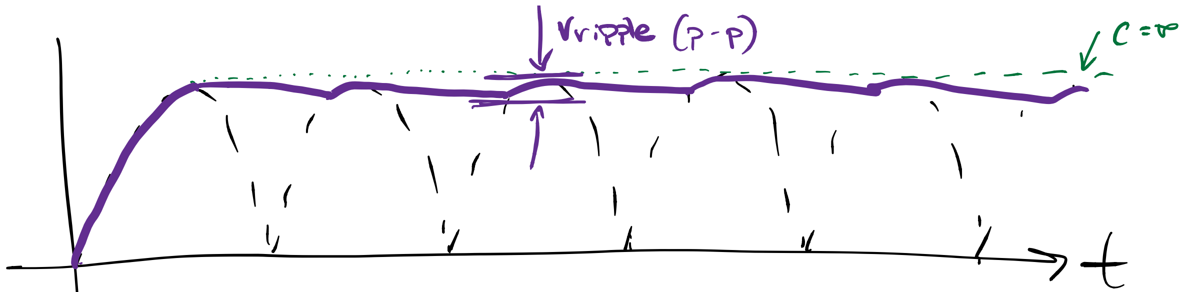
∴ we must "smooth" those peaks with <u>low-pass filter</u>; leave $\underbrace{\text{D.C. component}}_{f=0}$, get rid of A.C. component

$\boxed{\text{this class: capacitor input filter}}$



∴ purpose of capacitor is to <u>store charge</u> and <u>atempt to hold V_L</u> steady between rectified pulses

∴ called "filter capacitor" or "reservoir capacitor" due to its dual functionality!



∴ the capacitor will slightly discharge between pulses

∴ these variations are called ripple

∴ if $C = \infty$ or $R_L = \infty$ (and thus no load current to discharge C), there would be <u>zero ripple</u>; perfect D.C.!

∴ ripple is measured in $V_{P\text{-}P}$; typically we subtract <u>half</u> from peak rectified voltage to get an "average" V_L.