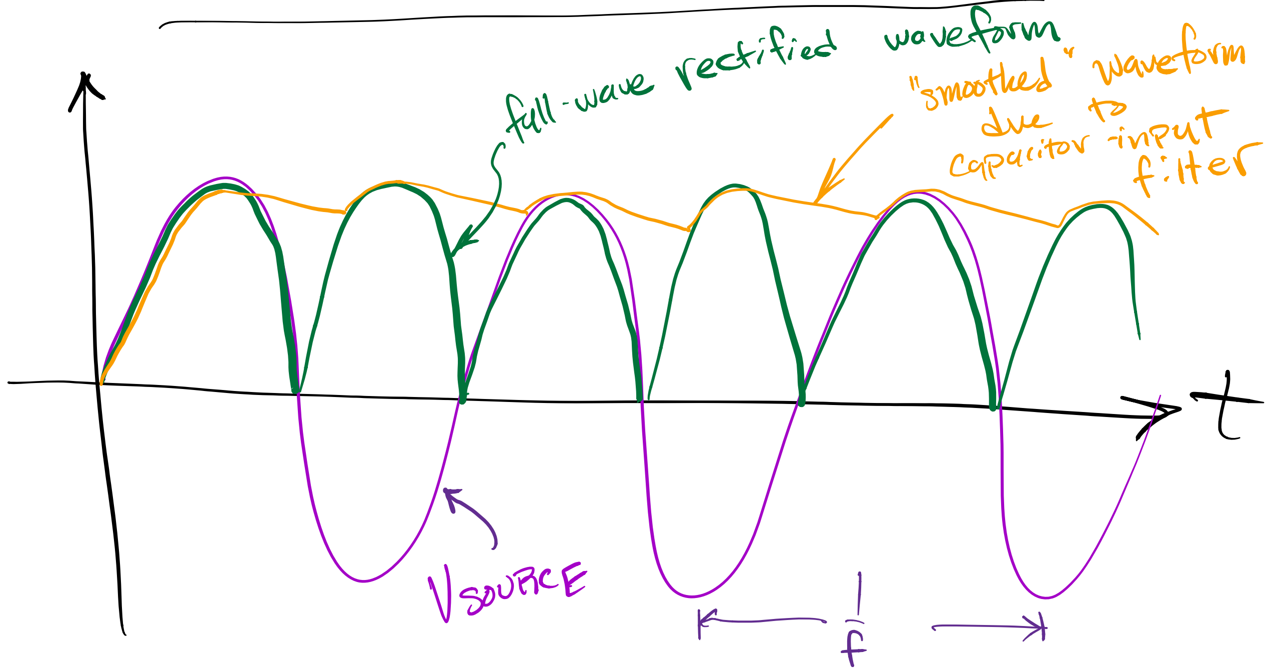
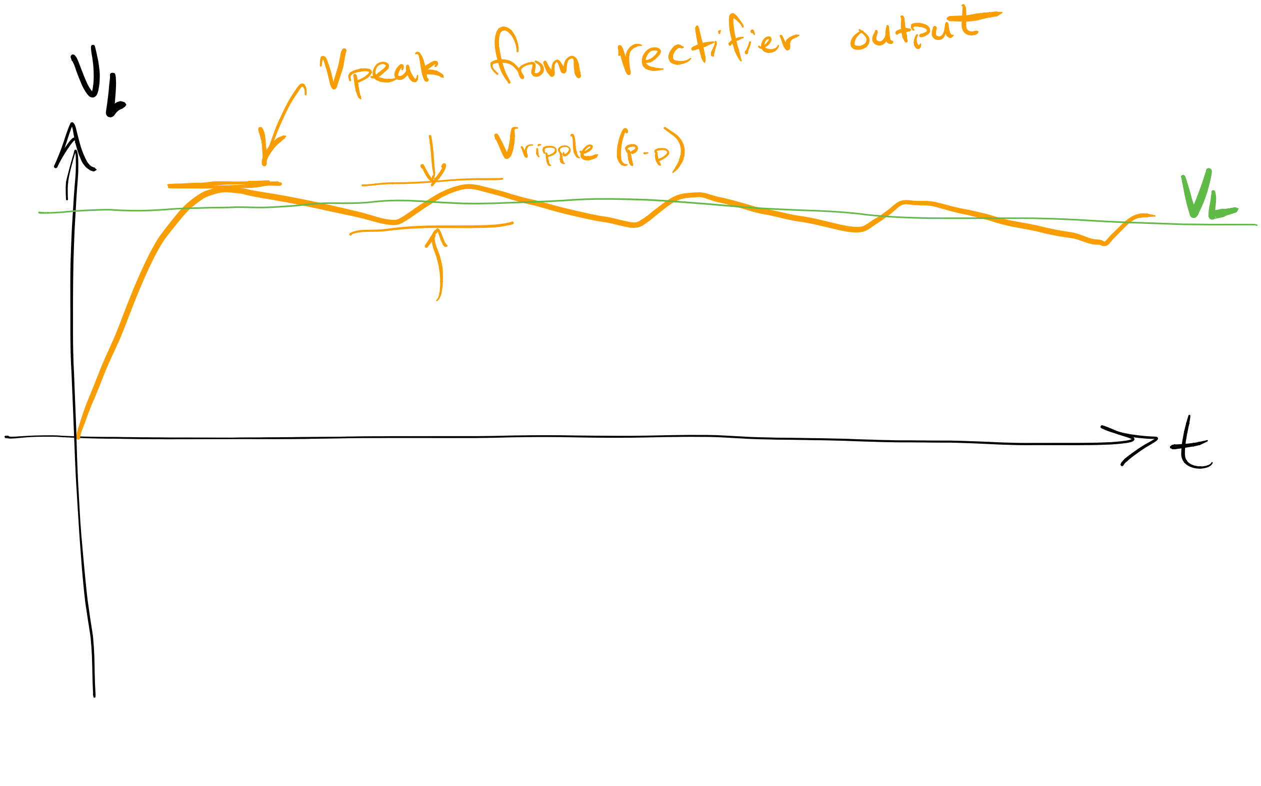
Capacitor-Input Filter





.. for capacitor-input filter, approximate formula for ripple voltage is:

$$\boxed{V_{ripple(p \cdot p)} = \frac{I_L}{2fC}}$$

where I_L = load current $\left(I_L = \frac{V_L}{R_L} \right)$

C = filter capacitor value

f = original frequency of source

→ 60 Hz in US, 50 Hz in many parts of Europe, etc..

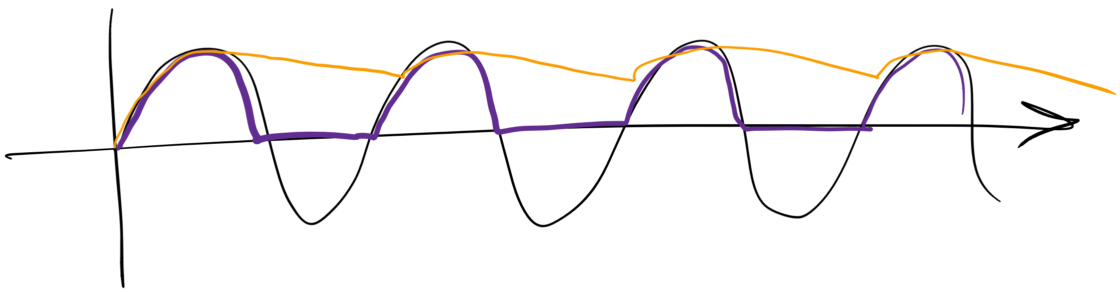
.. note: full-wave rectified waveform has fundamental frequency of 2f; often hear term "120 Hz ripple" or 100 Hz

... but f is the original line frequency

.. for <u>half-wave</u> rectifier :

$$V_{ripple\,(p\text{-}p)} = \frac{I_L}{fC}$$

.. twice the magnitude!



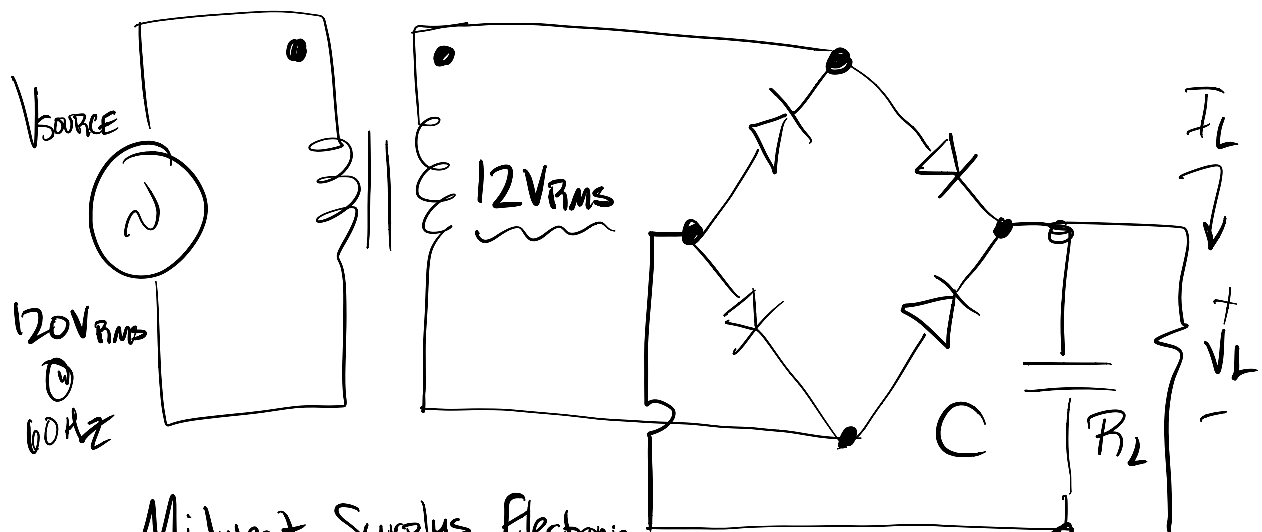
.. half-wave rectifiers seldom used in power supplies!

.. We call V_L the <u>D.C. component</u>

V_{ripple} the <u>A.C. component</u>

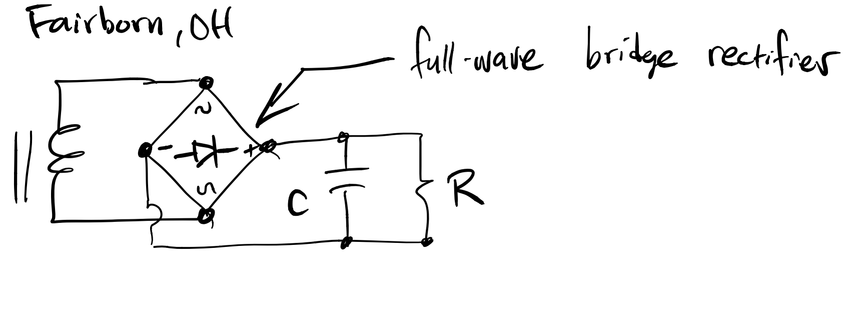
.. ideally, we want a <u>perfect</u> D.C. voltage and <u>zero</u> A.C. component; no ripple, no noise, etc.

.. usually try to further reduce V_{ripple} with more filtering or <u>regulation</u> → more later ex: Draw a linear power supply using a stepdown transformer, full-wave bridge rectifier, and capacitor-input filter. Determine V_L and $V_{ripple(p-p)}$ if $C = 100\,\mu F$, $V_S = 12\,V_{RMS}$, and $R_L = 200\,\Omega$. Assume $V_{SOURCE} = 120\,V_{RMS}$ @ 60 Hz.



Midwest Surplus Electronics
Fairborn, OH

alt. symbol:



$$V_{peak} = V_s\sqrt{2} - 2 \cdot V_D$$

"constant diode drop"
$= 0.7\,V$ for Si

$$= 12\sqrt{2} - 2 \cdot 0.7$$

$$= 15.57\ V_{peak}$$

$\therefore$ we need I_L in order to approximate ripple voltage; however, this requires V_L, which is $V_{peak} - \frac{1}{2}V_{ripple}$!!!

$\therefore$ let's assume $V_{ripple} \lll V_L$

then $V_L \approx V_{peak}$

$$I_L \approx \frac{V_{peak}}{R_L} = \frac{15.57}{200} = 0.07784\,A$$

or ~ 78 mA

$\therefore \; V_{ripple} = \dfrac{I_L}{2fC} \simeq \dfrac{0.078}{2 \cdot 60 \cdot 100 \times 10^{-6}}$

$= 6.5 \; V_{P\text{-}P}$

∴ way too high !!!

∴ violates the assumption of $V_{ripple} \lll V_{peak}$

∴ usually, max. permissible voltage is specified as a percentage of V_L, such as 1% or 5%.

∴ try increasing C to 470 μF

then $V_{ripple} \simeq \dfrac{0.078}{2 \cdot 60 \cdot 470 \times 10^{-6}} = 1.38 \; V_{PP}$

∴ much better

∴ $< 10\% \; V_L$

∴ recalculate V_L:

$V_L = V_{peak} - \frac{1}{2} V_{ripple} = 15.57 - \frac{1}{2}(1.38) = \boxed{14.88 \, V}$

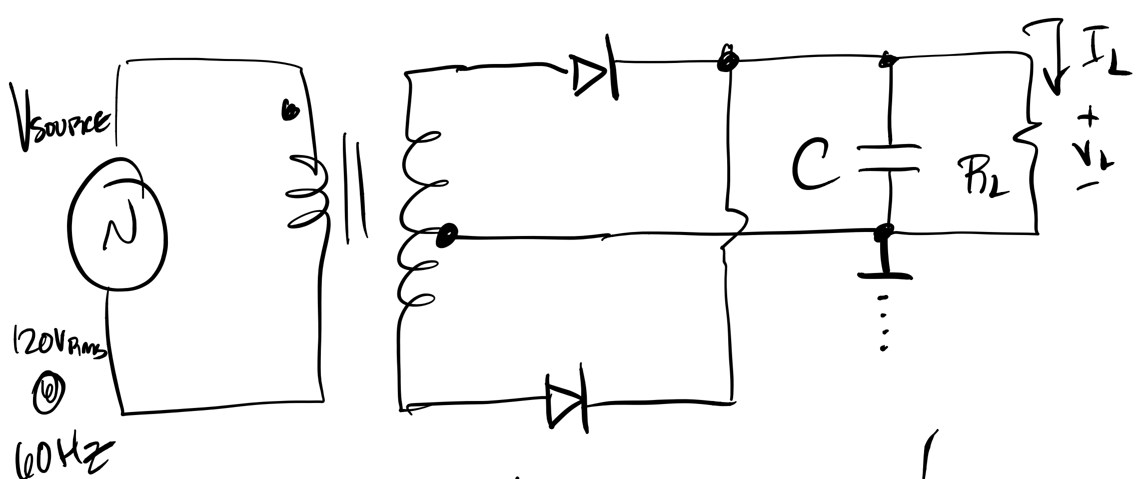
∴ side note: capacitors used for smoothing/filtering are usually <u>electrolytic</u>

→ tolerance is seldom ±10%
usually worse!

→ usually <u>only</u> available in <u>E6 values</u>

{10 15 22 33 47 68}

homework:



∴ both Si diodes!

- what type of rectifier is this?
- is it half-wave or full-wave?
- determine V_{peak} and calculate C for

give E6 value!

$< 5\%$ ripple if

$I_L = 200mA$ and $V_S = 350-0-350\ V_{RMS}$

$\left(\text{meaning, } \frac{V_{ripple}}{V_L} < 5\%\right)$

- determine final V_L