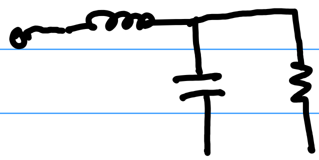
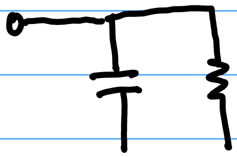
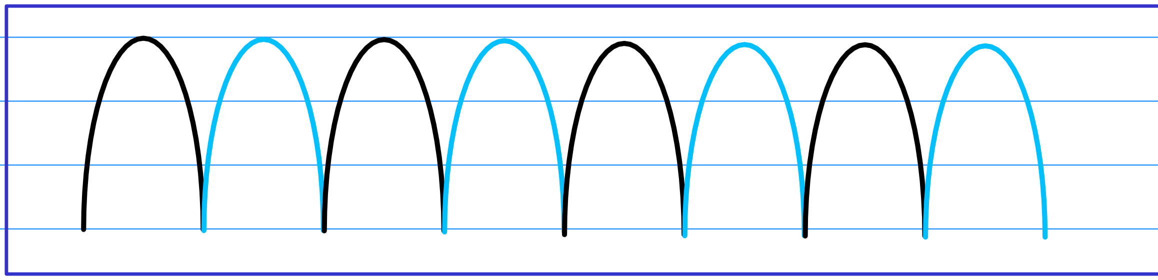
Rectifier (H.1)

20170405

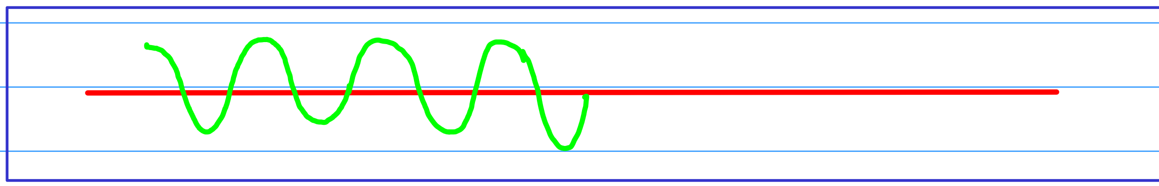
Filter

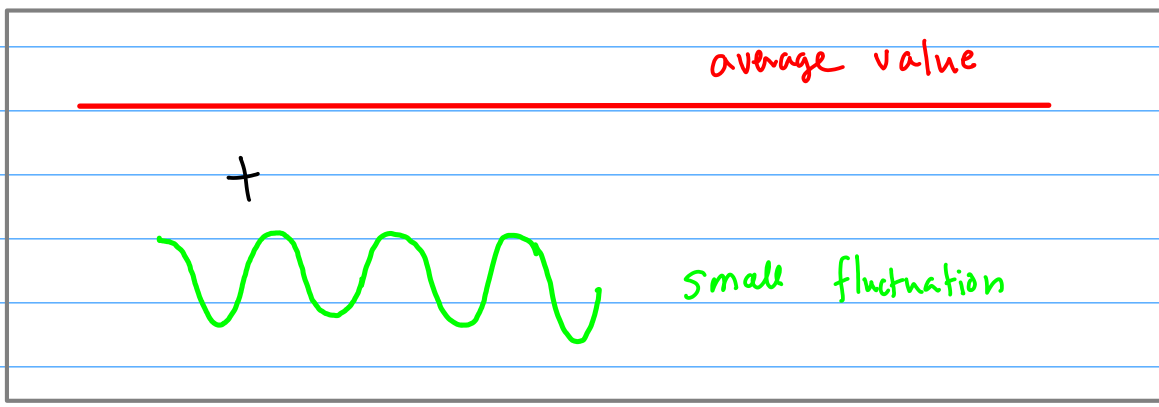
① Choke-input Filter  LRC

② Capacite-input Filter  RC full-wave rectifier output

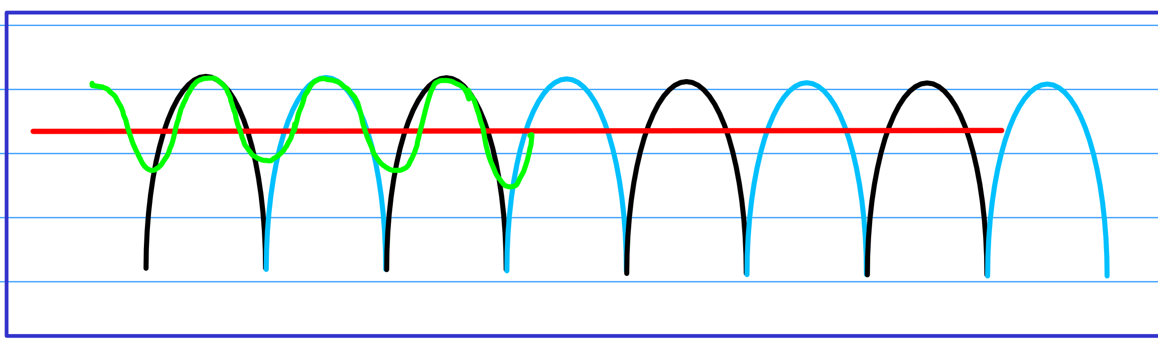


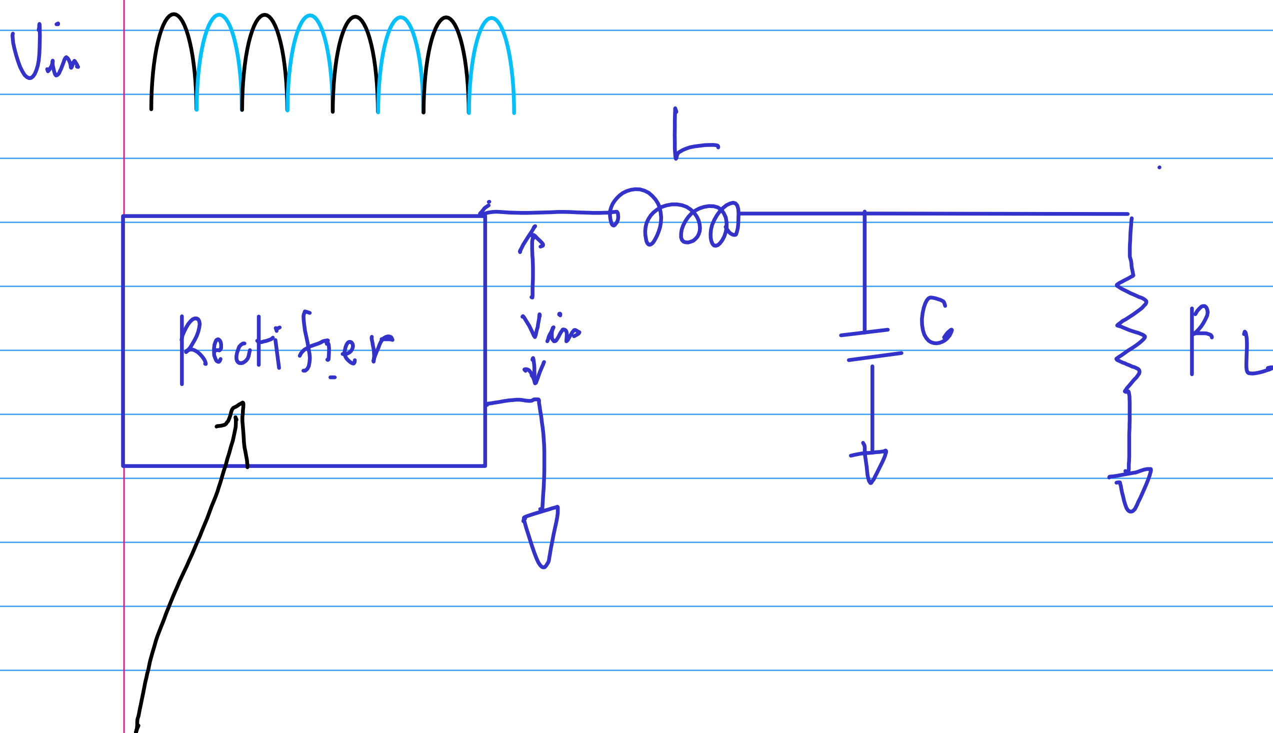
View this as bellows DC+ AC



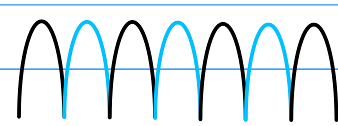


Supper position



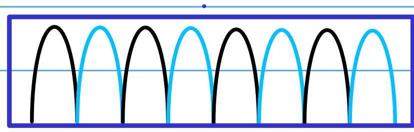


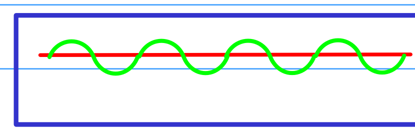
1. Full-wave Rectifier
2. Bridge Rectifier



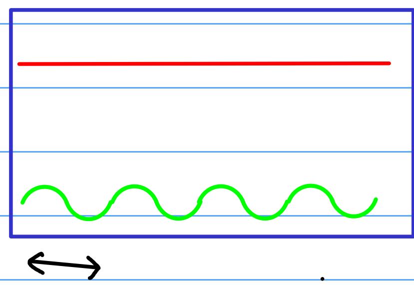
$V_{in} = V_{in(dc)} + V_{(ac)}$

V_{in}





$=$ $V_{in(dc)}$ $+$ $V_{(ac)}$



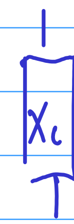
T $\quad \omega = 2\pi f = \frac{2\pi}{T}$

$\Rightarrow$

$X_C = \frac{1}{2\pi f C}$

$X_L = 2\pi f L$

$C \uparrow$

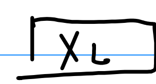


$X_C \downarrow$

$X_L \gg X_C$

$R \gg X_C$

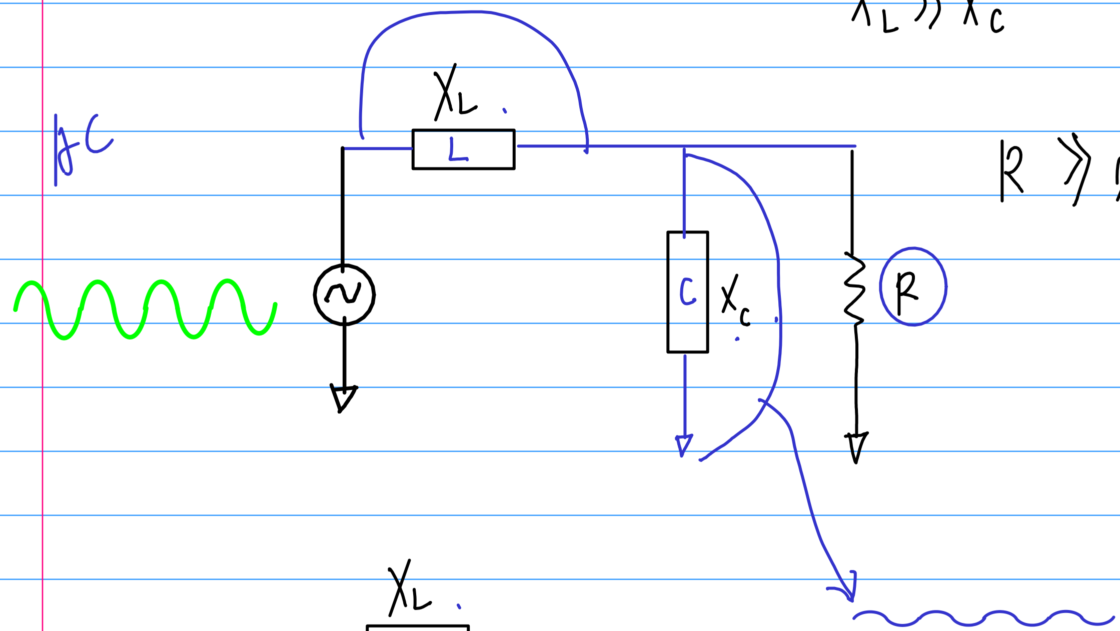
$L \uparrow$

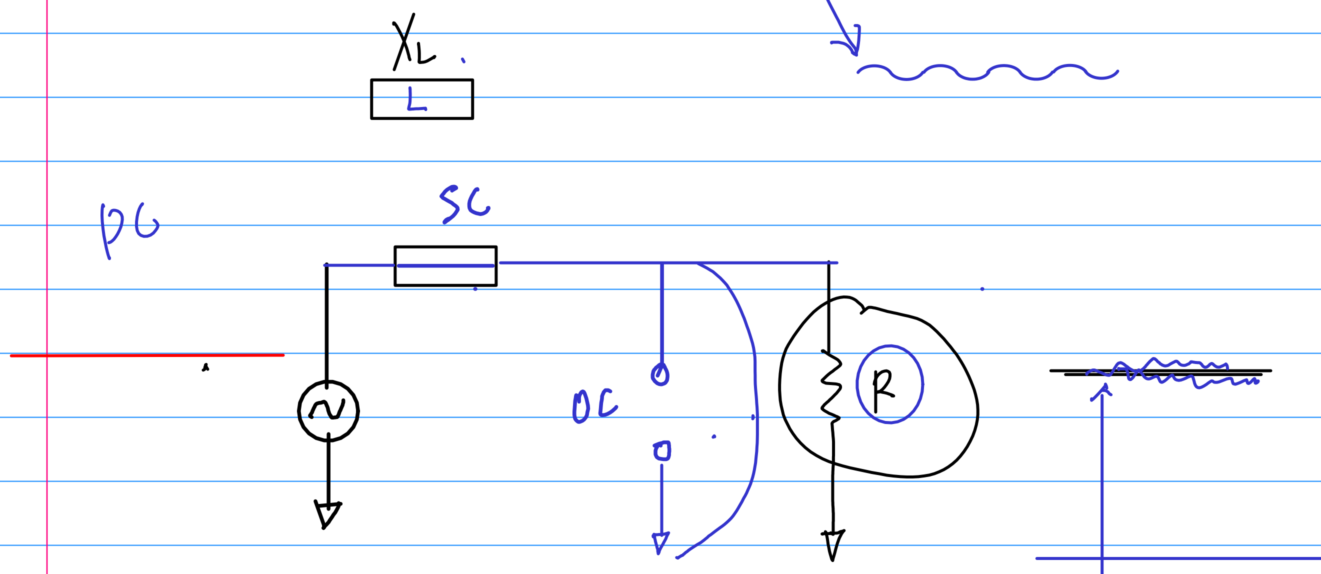


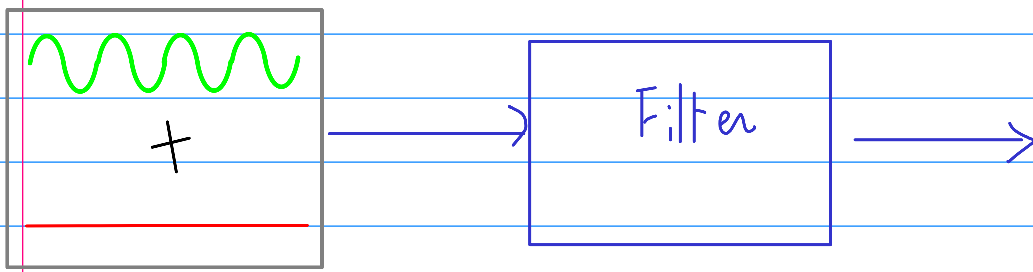
$X_L \uparrow$

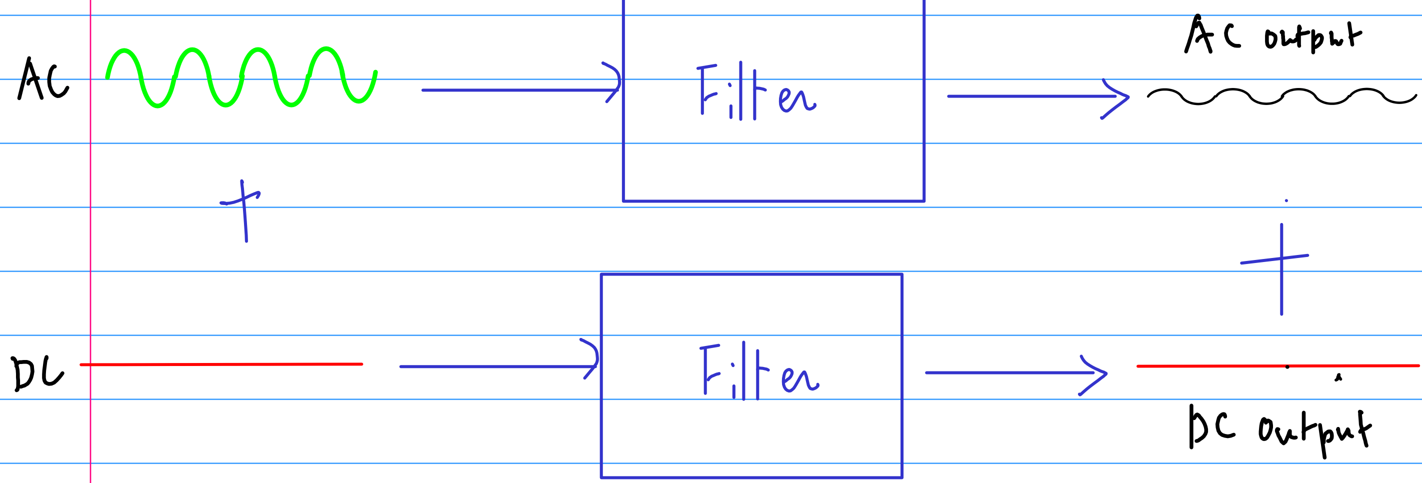
$X_L \gg X_C$

$R \gg X_C$

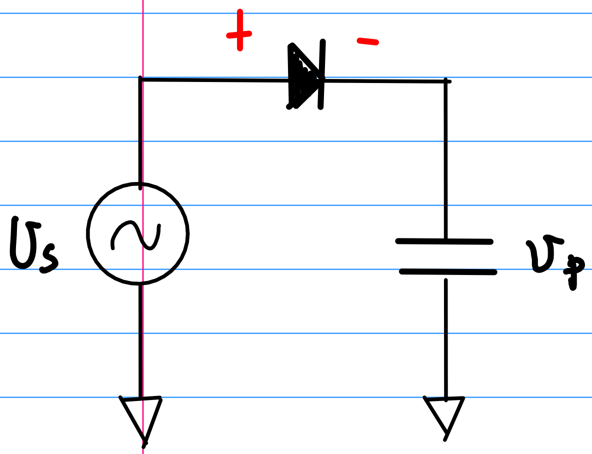


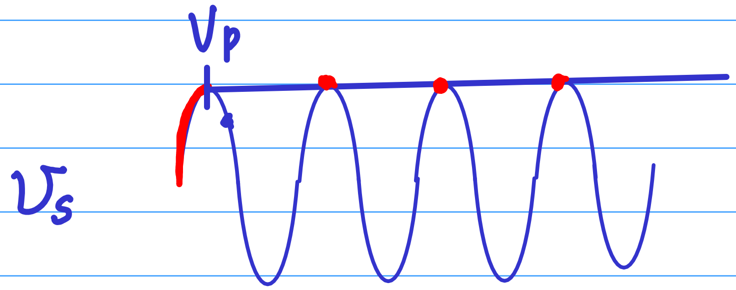



+
Filter

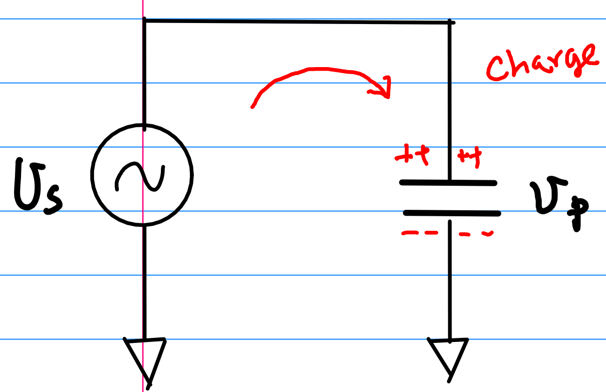

AC
+
DC
Filter
Filter
AC output
+
DC output

Capacitor - Input Filter

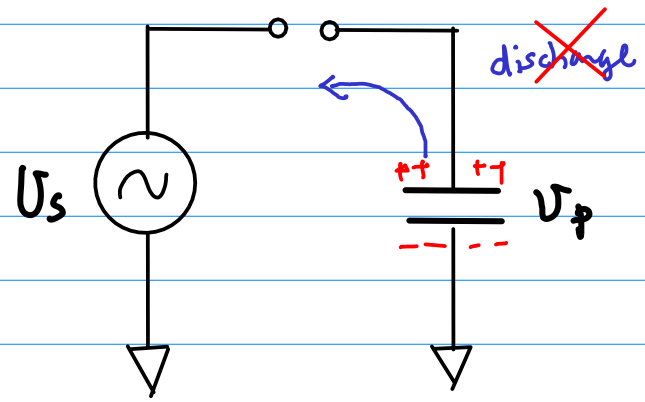


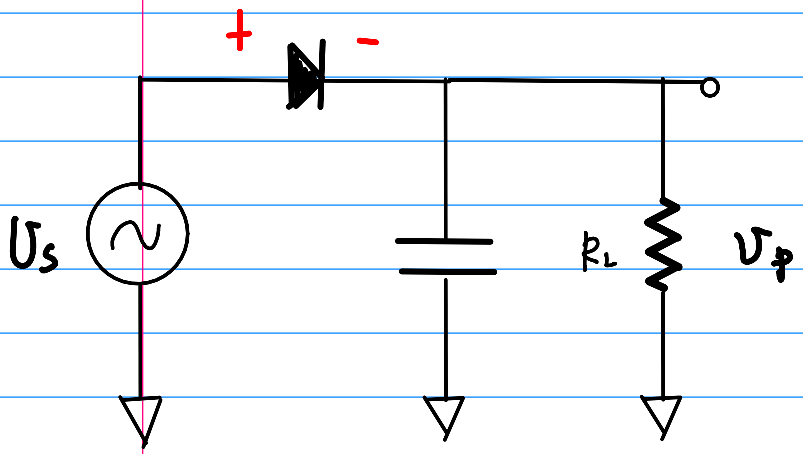


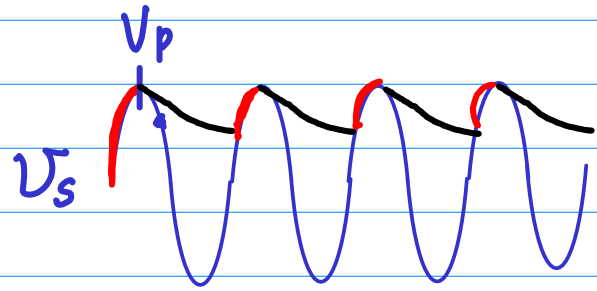
$V_s \geq V_p$



$V_s < V_p$

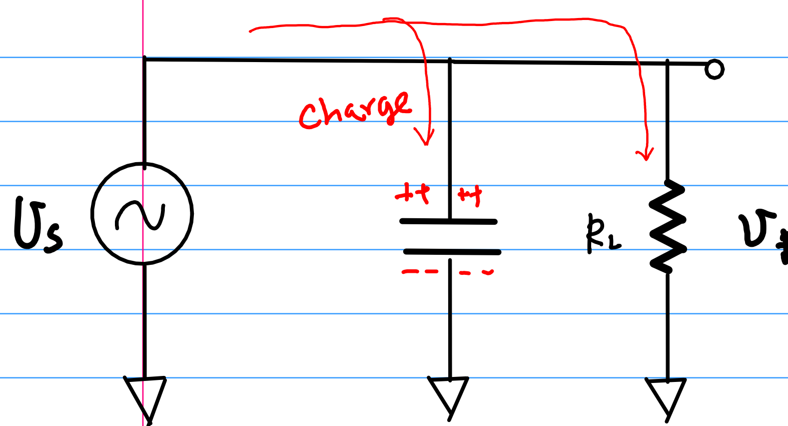


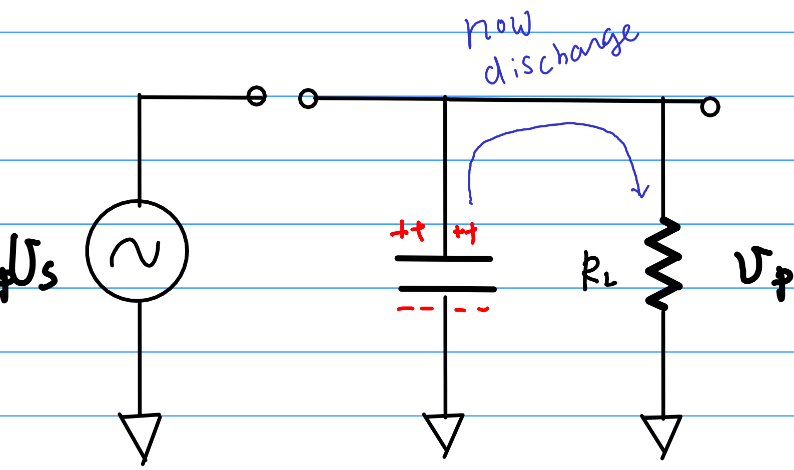




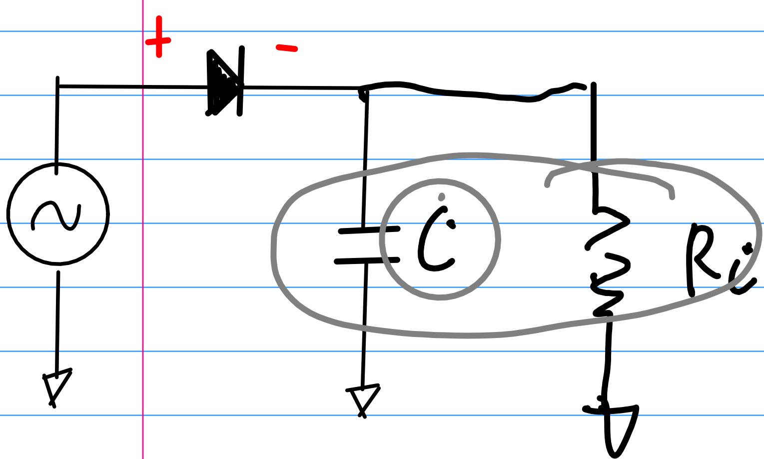
$v_s \geq v_p$

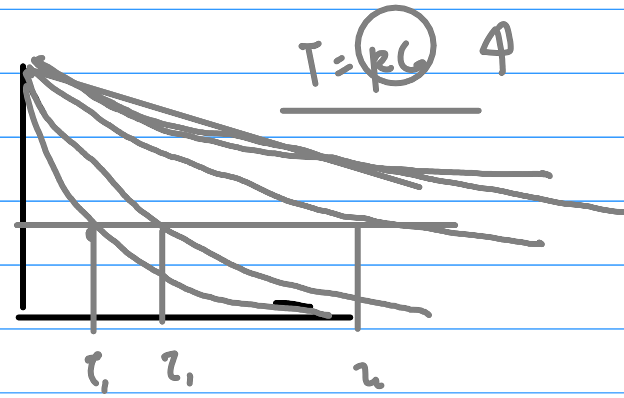
$v_s < v_p$

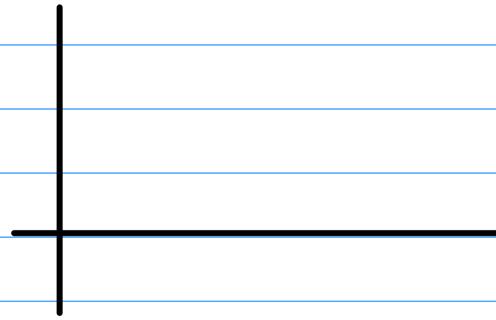


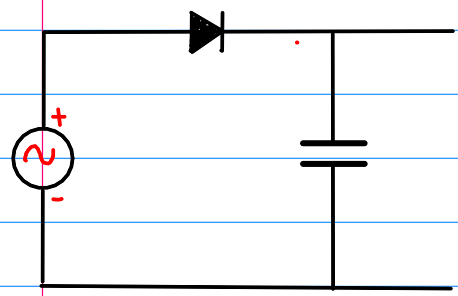


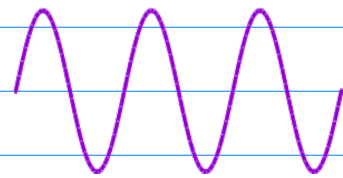
e^{-t}

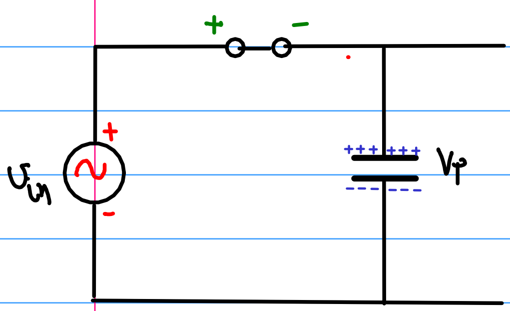


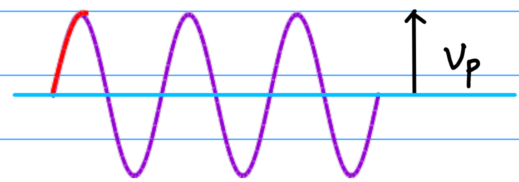


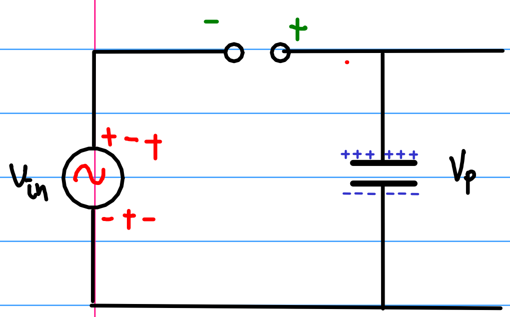


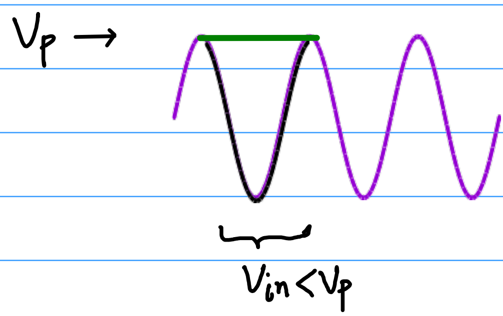


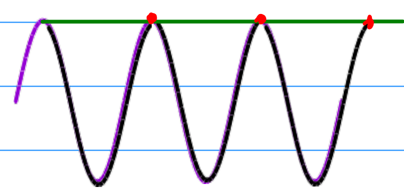



Vin
Vp


Vp

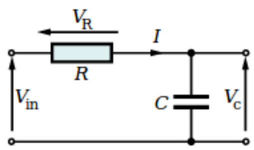

Vin
Vp


Vp →
Vin<Vp



Transient Response

Charge



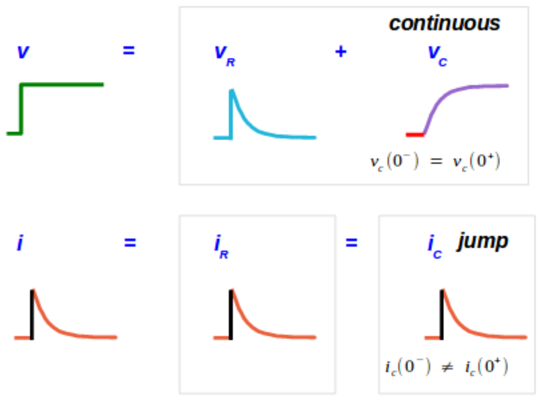
$$i_c = C \cdot \frac{d\,v_c}{d\,t}$$

unyielding voltage

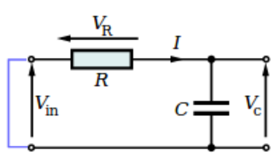
current jump

the capacitor voltage slowly follows the shape of the applied step input voltage

the capacitor current changes abruptly by the applied step input voltage and then slowly becomes zero



Discharge



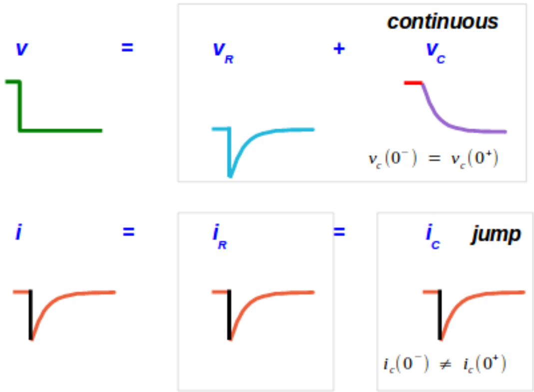
$$i_c = C \cdot \frac{d\,v_c}{d\,t}$$

unyielding voltage

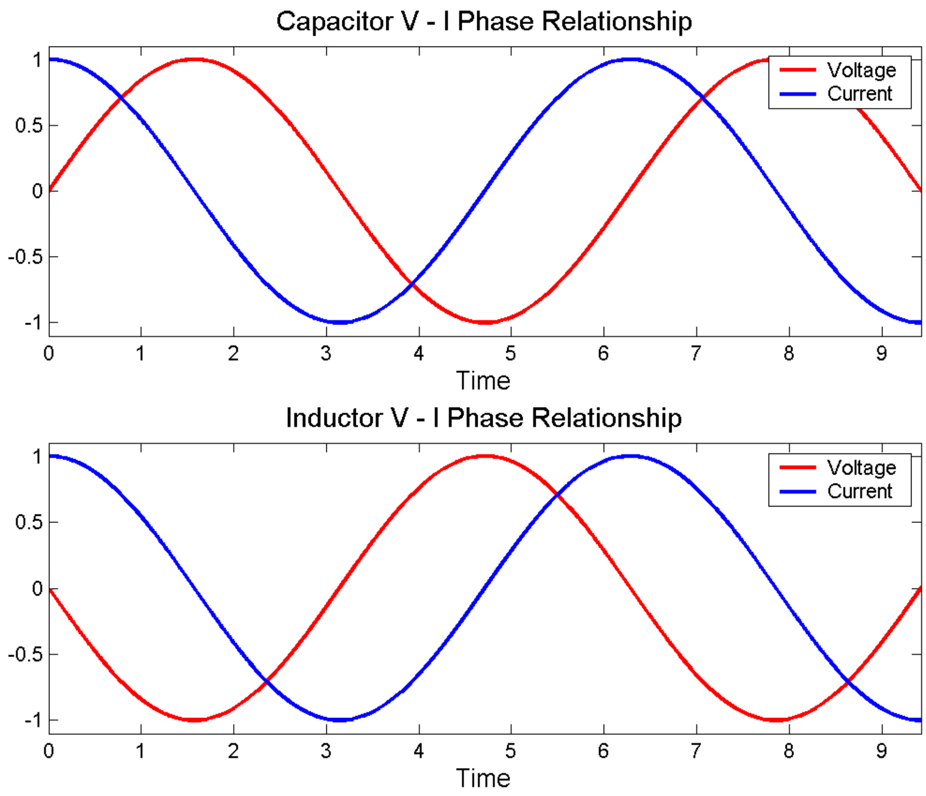
current jump

the capacitor voltage slowly follows the the shape of the applied step input voltage

the capacitor current changes abruptly by the applied step input voltage and then slowly becomes zero



Steady State



https://en.wikipedia.org/wiki/Electrical_impedance

The phase angles in the equations for the impedance of capacitors and inductors indicate that the voltage across a capacitor *lags* the current through it by a phase of $\pi/2$, while the voltage across an inductor *leads* the current through it by $\pi/2$. The identical voltage and current amplitudes indicate that the magnitude of the impedance is equal to one.

Capacitor [edit]

For a capacitor, there is the relation:

$$i_{\mathrm{C}}(t) = C\frac{\mathrm{d}\,v_{\mathrm{C}}(t)}{\mathrm{d}\,t}$$

Considering the voltage signal to be

$$v_{\mathrm{C}}(t) = V_p \sin(\omega t)$$

it follows that

$$\frac{\mathrm{d}\,v_{\mathrm{C}}(t)}{\mathrm{d}\,t} = \omega V_p \cos(\omega t)$$

and thus

$$\frac{v_{\mathrm{C}}\,(t)}{i_{\mathrm{C}}\,(t)} = \frac{V_p \sin(\omega t)}{\omega V_p C \cos(\omega t)} = \frac{\sin(\omega t)}{\omega C \sin\left(\omega t + \frac{\pi}{2}\right)}$$

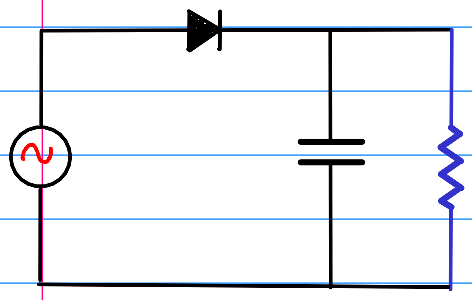
This says that the ratio of AC voltage amplitude to AC current amplitude across a capacitor is $\frac{1}{\omega C}$, and that the AC voltage lags the AC current across a capacitor by 90 degrees (or the AC current leads the AC voltage across a capacitor by 90 degrees).

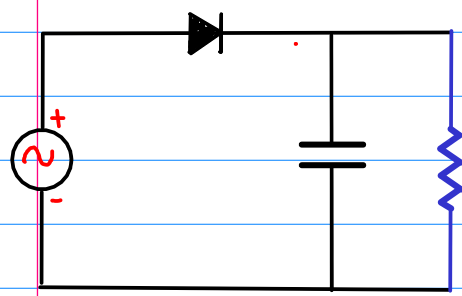
This result is commonly expressed in polar form as

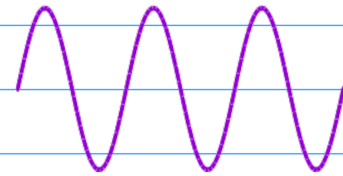
$$Z_{\mathrm{capacitor}} = \frac{1}{\omega C} e^{-j\frac{\pi}{2}}$$

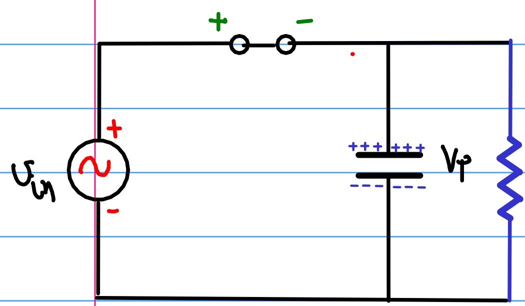
or, by applying Euler's formula, as

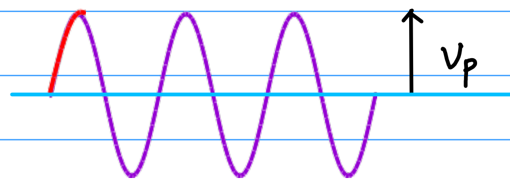
$$Z_{\mathrm{capacitor}} = -j\frac{1}{\omega C} = \frac{1}{j\omega C}$$

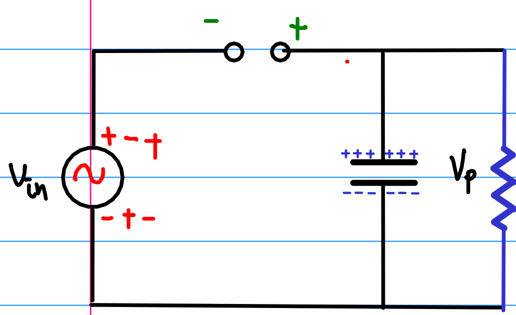


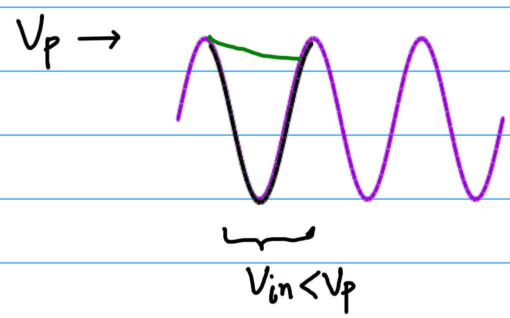


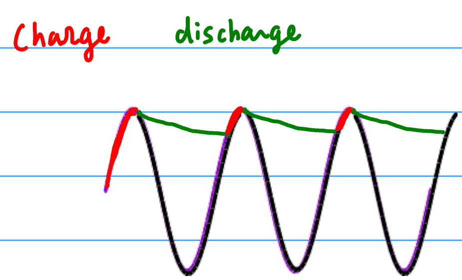



Vin
Vp


Vp


Vin
Vp


Vp →
Vin < Vp


Charge
discharge