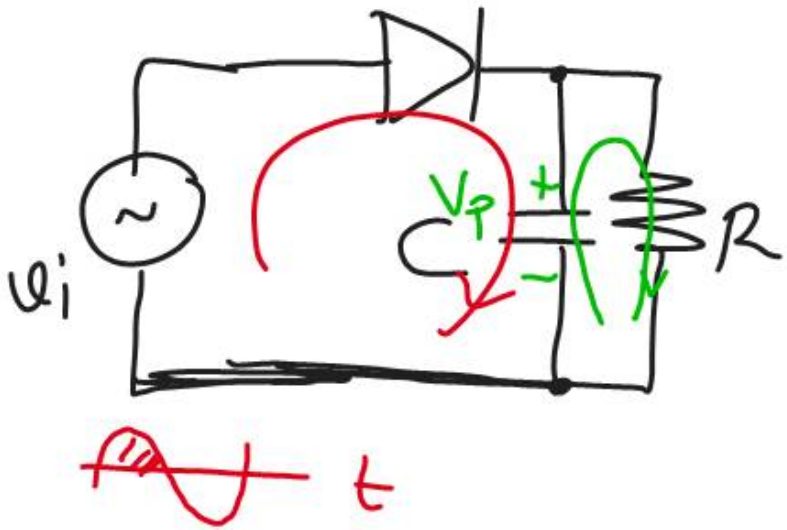
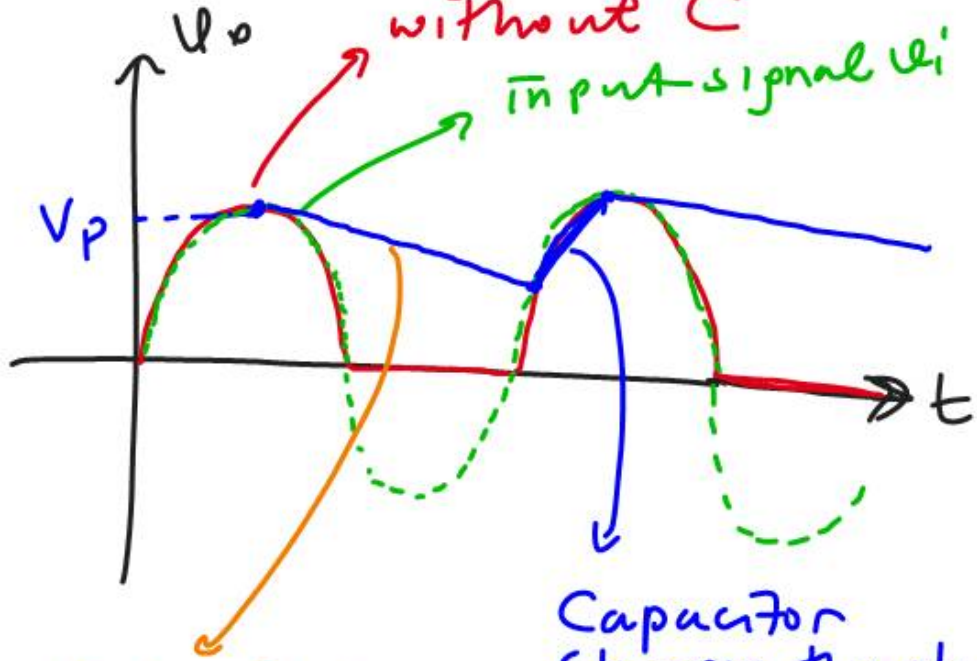
08.03.2011
CZ

A Rectifier with a Filter





Capacitor charging

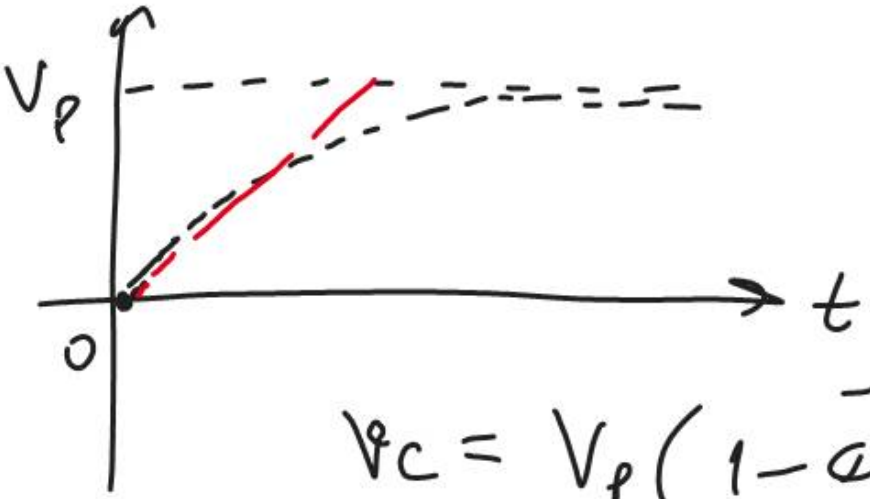
$$u_c = u_o = V_p\left(1 - e^{-t/r_d C}\right)$$

$$\tau = r_d \cdot C$$

$$r_d = \frac{dI}{dV}$$

(diode dynamic resistance)

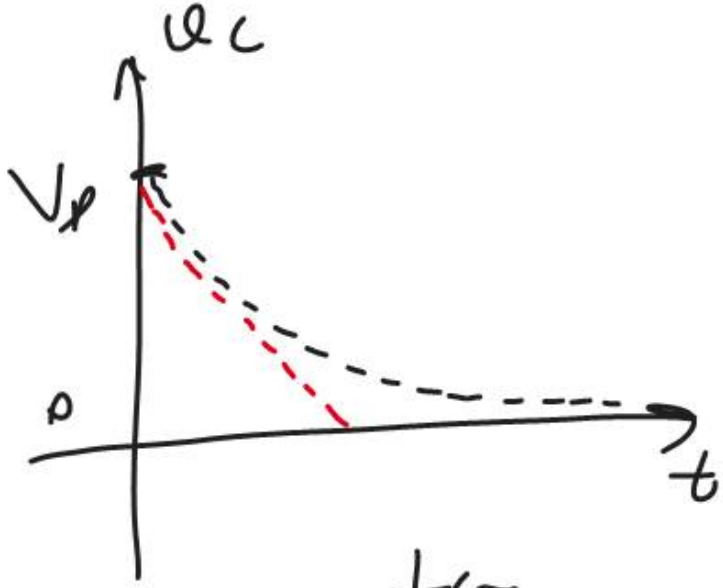
~ 3 – 5 Ω



$$v_C = V_p\left(1 - e^{-t/\tau_c}\right)$$

$\tau_c = r_d \cdot C$

CHARGING



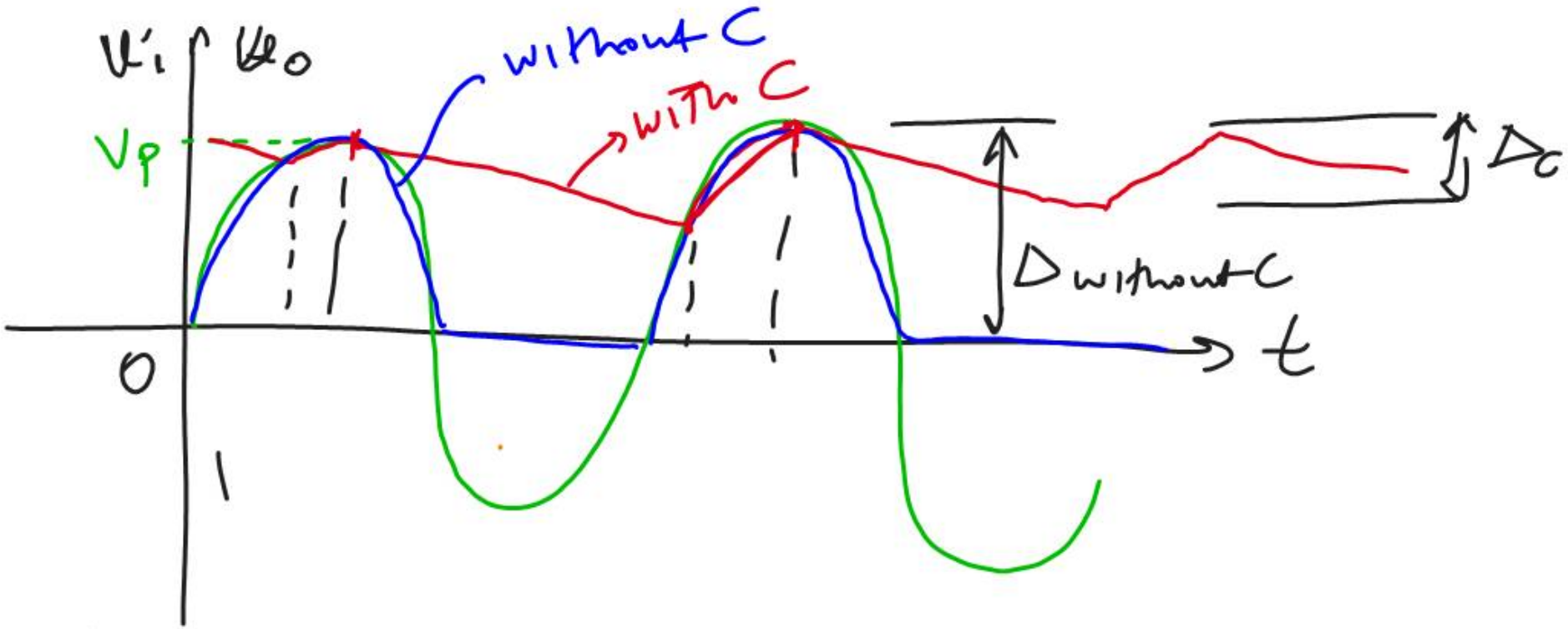
$$v_C = V_p \cdot e^{-t/\tau_D}$$

$\tau_D = R \cdot C$

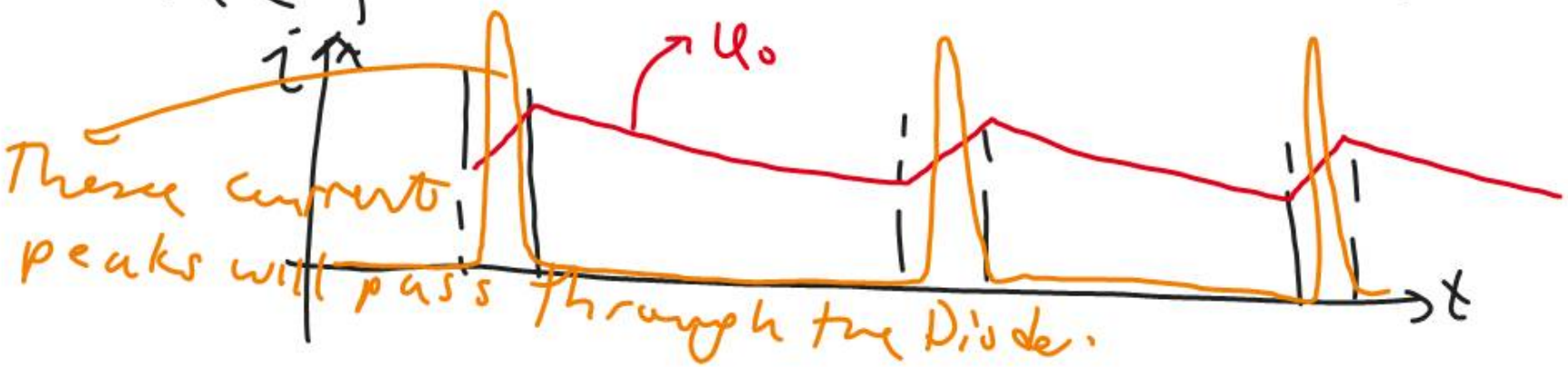
DISCHARGING

$\tau_D >> \tau_c$

$R \cdot C >> r_d C$

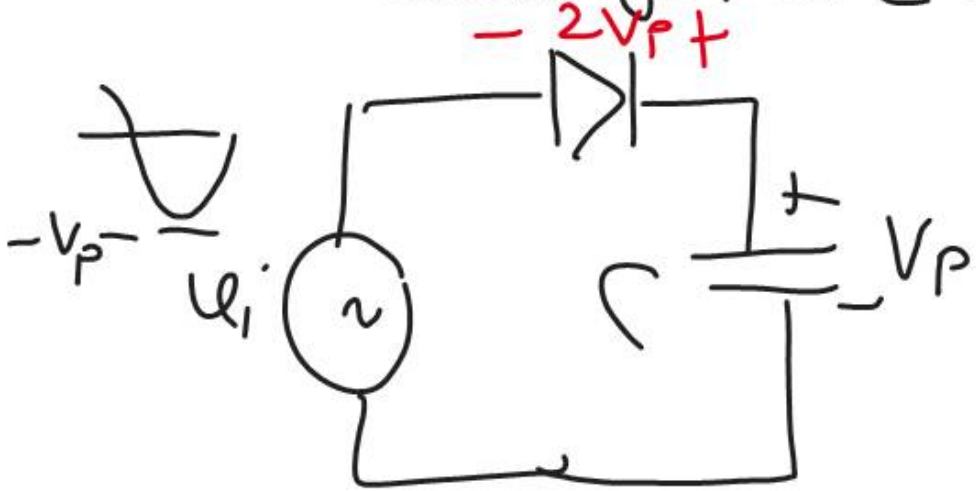


With the C added, the ripple at the output voltage is reduced (R and C form a low pass RC filter which smooths the output voltage)

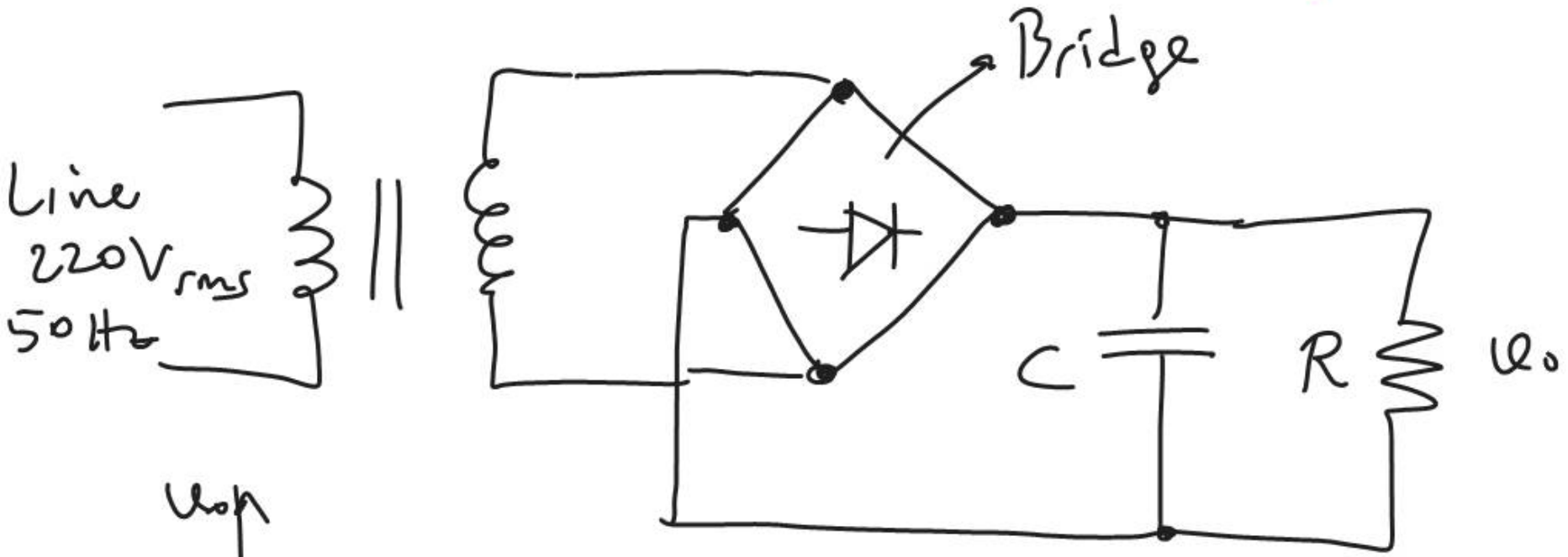


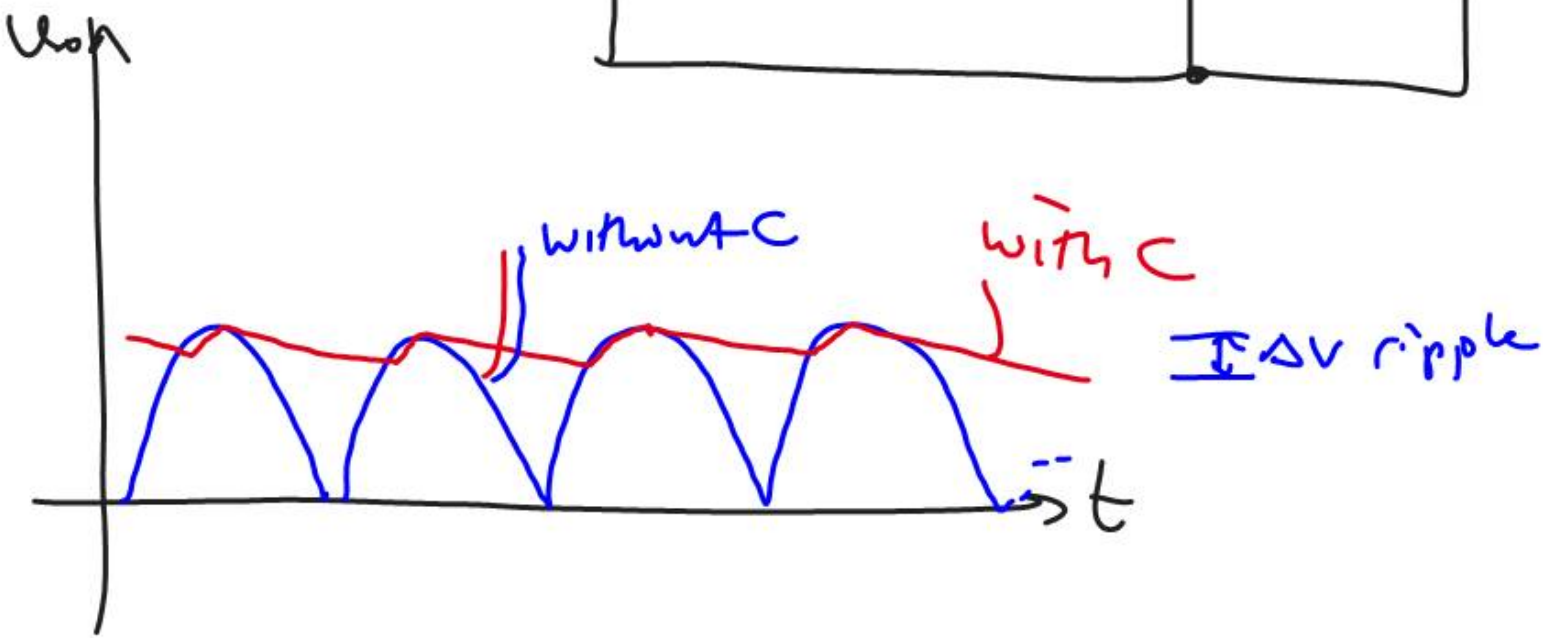
Therefore in reducing RIPPLE we have the price to pay for:

- Peak current through the diode (because of C charging)
- Peak inverse voltage (PIV) doubled because of the C: ($PIV \approx 2V_p$)



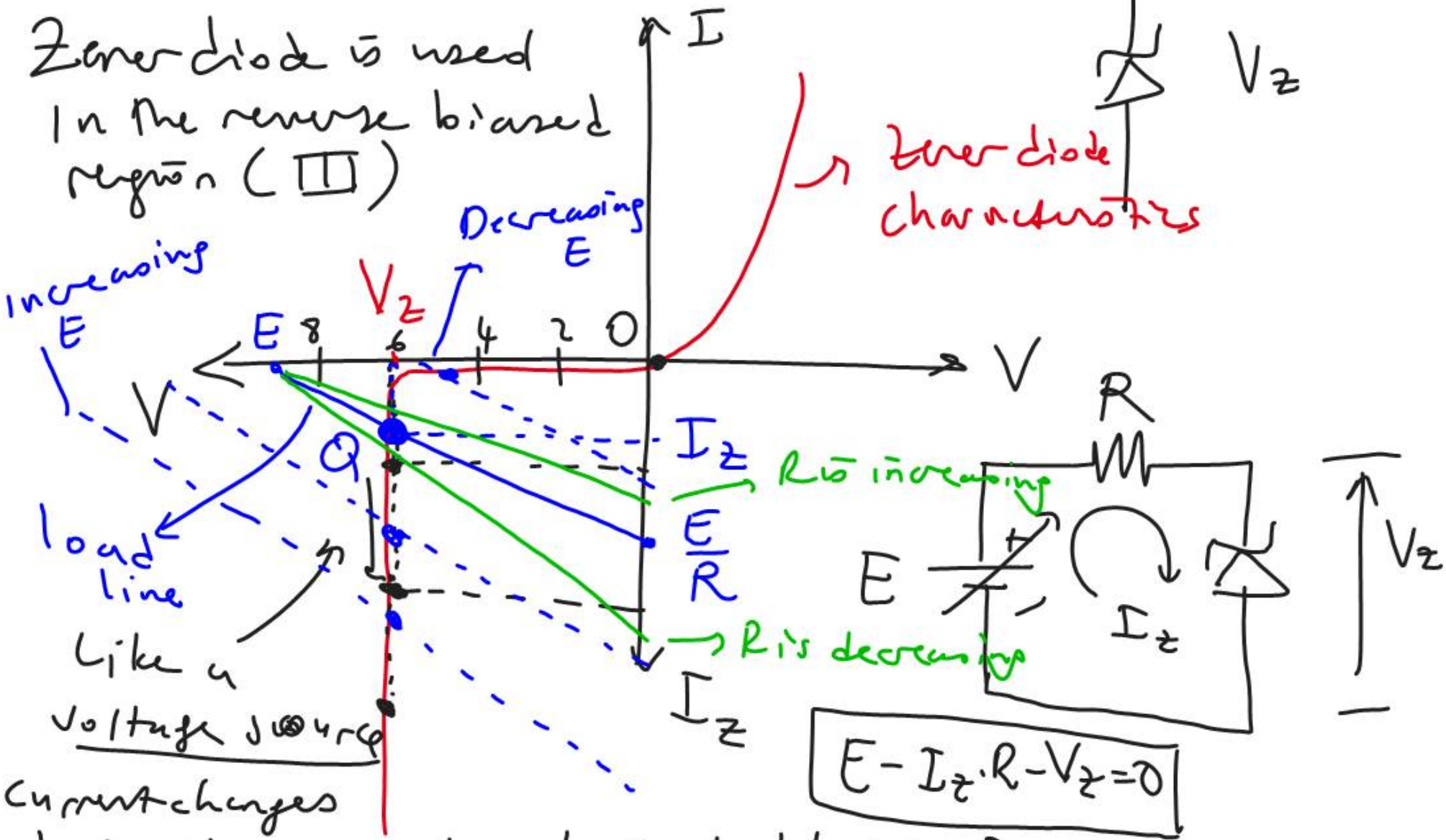
A full-wave rectifier with filter



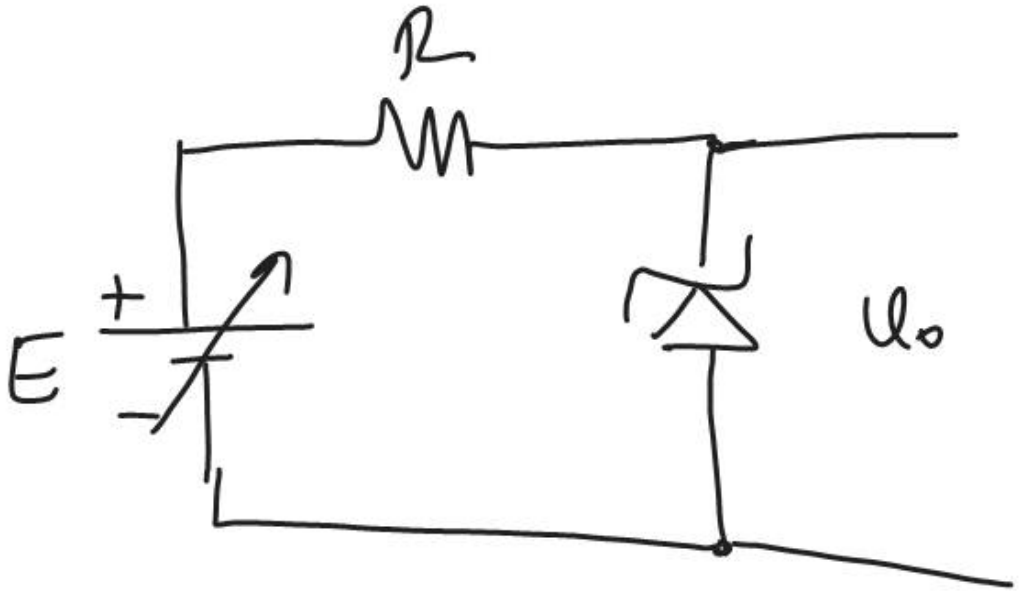


the ZENER DIODE

Zener diode is used in the reverse biased region (III)



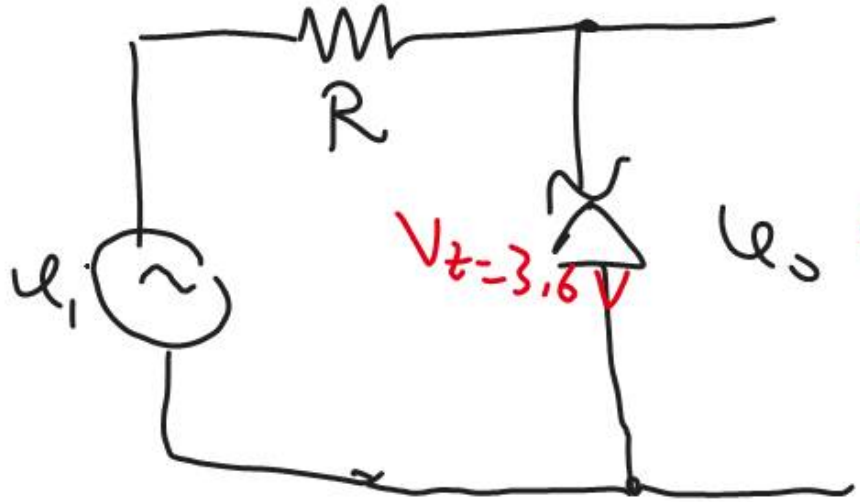
Zener diode is used as a REGULATOR
(to obtain a constant voltage)

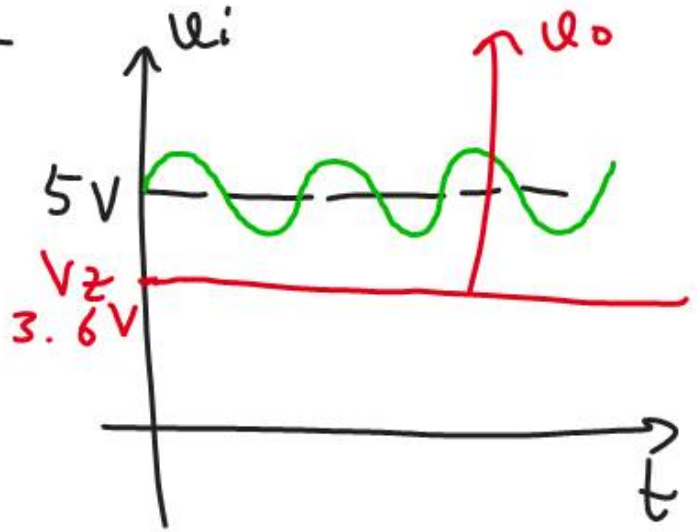


if $E > V_z$

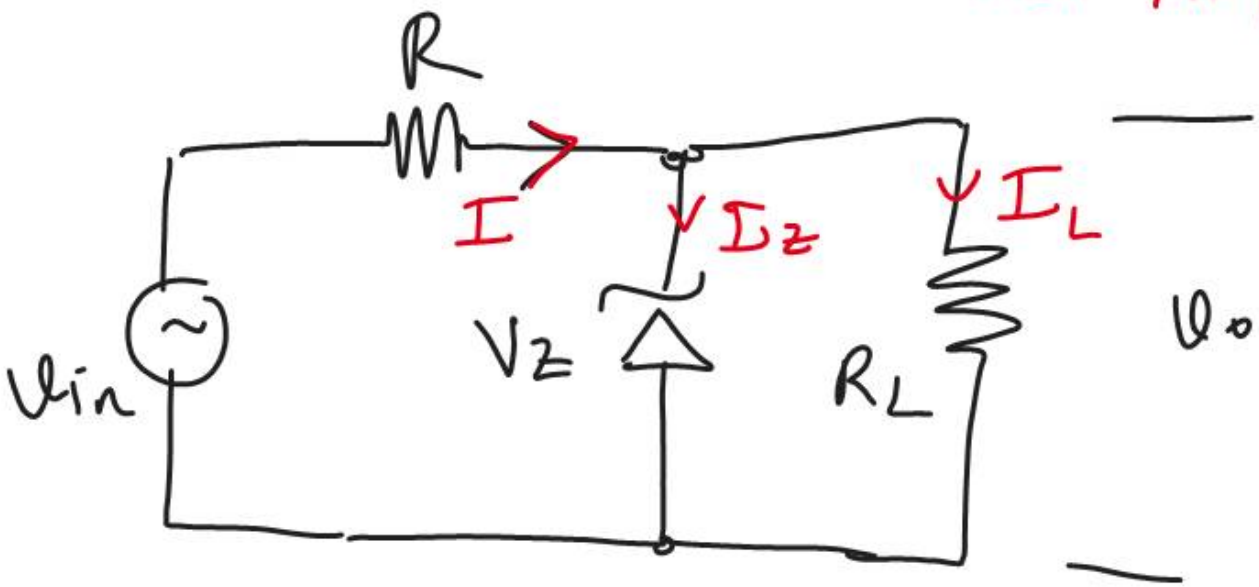
$u_o = V_z$

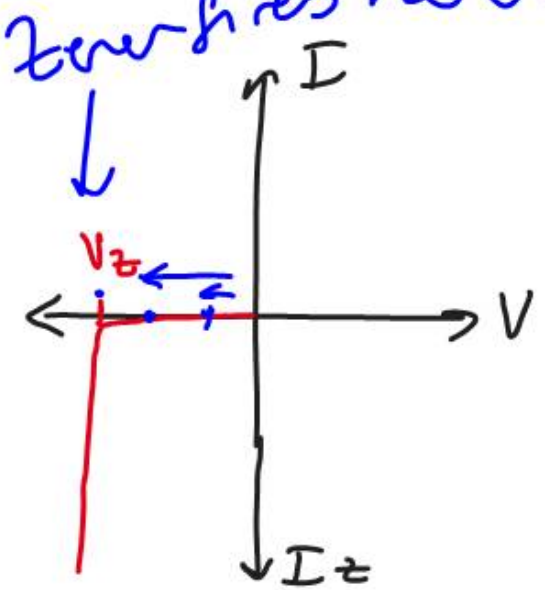
ex





When we have a R_L in parallel with V_z:





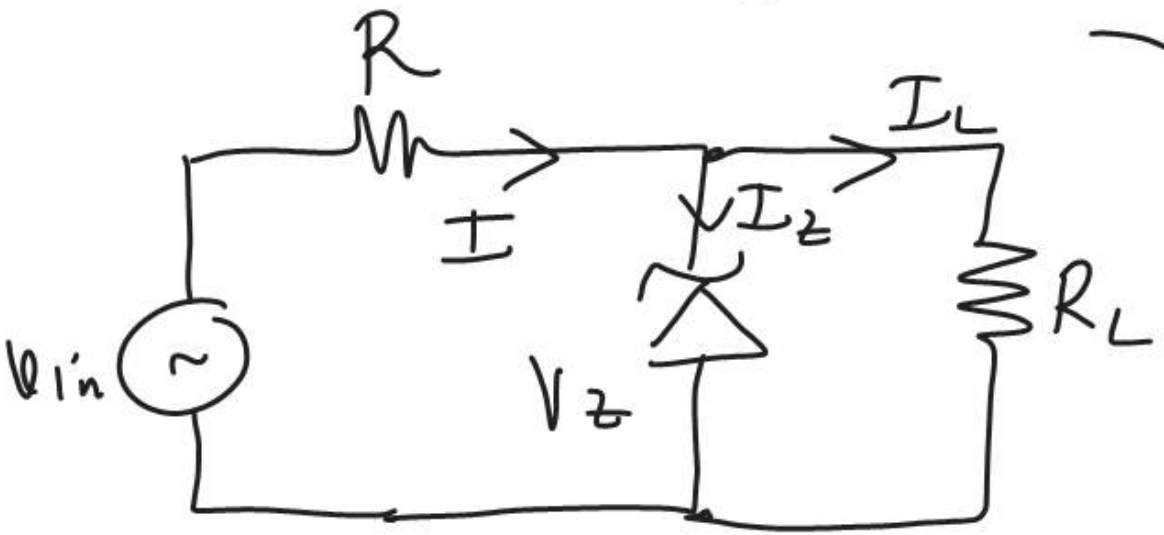
$$V_o = \frac{V_{in}}{R+R_L} \cdot R_L$$

when Zener does not fire
(i.e when it is open-circuit)

$$\frac{V_{in}}{R+R_L} \cdot R_L \geq V_z \Rightarrow \text{for the zener to fire}$$

when zener fires $\underline{V_o = V_z}$

When zener fires (i.e. when $\frac{V_{in}}{R+R_L} \cdot R_L \geq V_z$)



$V_o = V_z$

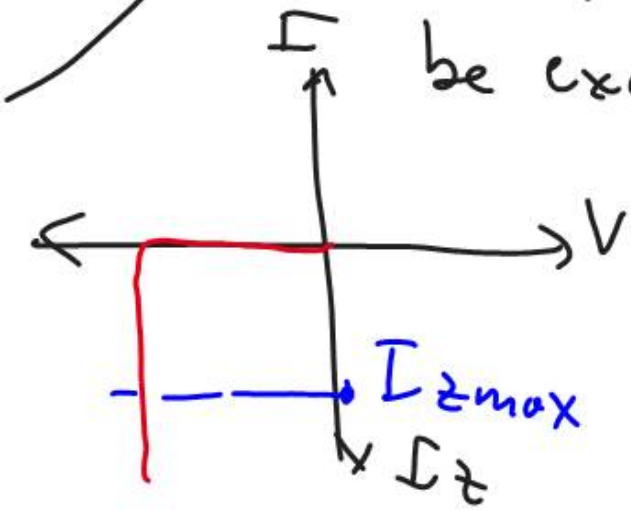
$I_L = \frac{V_z}{R_L}$ constant.

$I = I_L + I_z$

$I = \frac{V_{in} - V_z}{R}$

There is a limit for I_z

I_{zmax} should not be exceeded!



A Zener can regulate the input voltage change, or a change in R_L:

It provides:

1 - Line Regulation (V_{in} changes, R_L constant)

2 - Load Regulation (V_{in} constant, R_L changes)

1. LINE REGULATION with ZENER DIODE