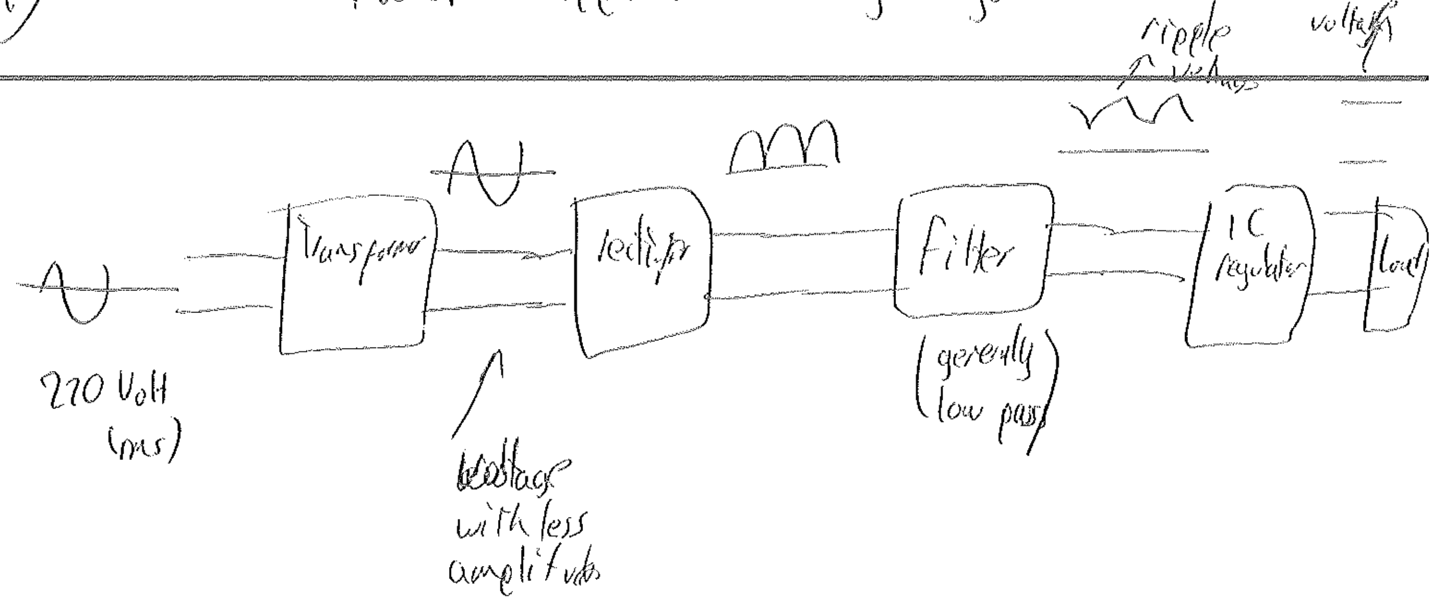
1

Power Supplies (Voltage Regulators)

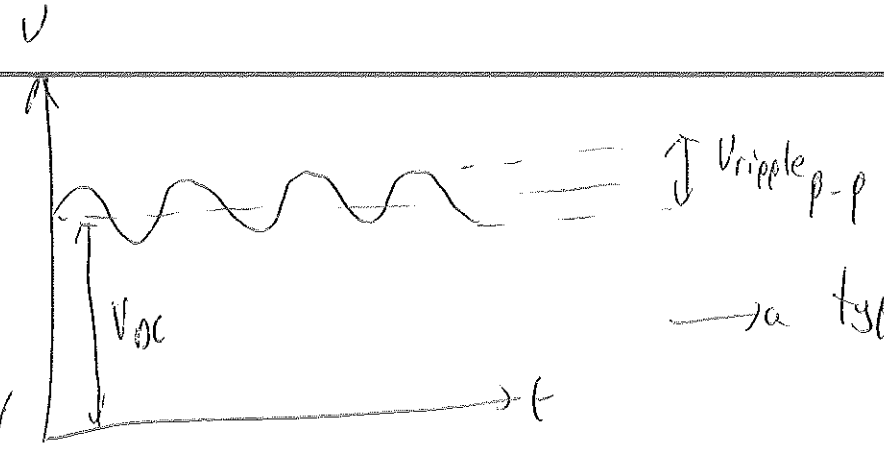


The process of obtaining DC from AC voltage

General filter considerations

- A rectifier circuit is necessary to convert a zero average voltage (ex: 220 Volt (rms) electricity from the network) to a nonzero average voltage (DC, 24 Volt, 12 Volt, 48 Volt)
- Output of the prosess is a pulsating DC voltge
- This DC can be used to charge a battery, as average DC voltage is large enough to perform charging of a battery
- Filter is important for pure DC to accomplish jobs related with computers, radio and stereo systems, This will clear the pulsating DC forms

② Filter Voltage Regulation and Ripple Voltage



→ a typical filtered output

V_{DC} → DC value
$V_{ripple_{p-p}}$ → AC variation at DC (ripple voltage)

↳ This is obtained from some AC source after rectification so it has ripple but generally battery voltage doesn't contain ripple voltage

– As ripple is smaller the quality of DC increases

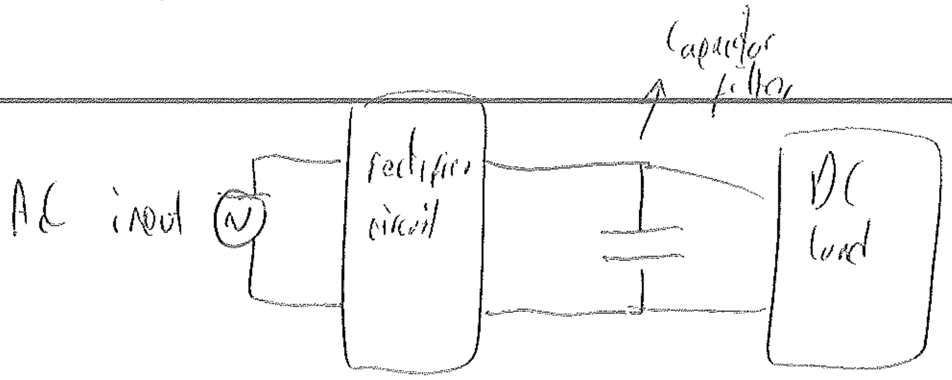
$$r = \frac{\text{ripple voltage (rms)}}{\text{DC voltage}} = \frac{V_r(rms)}{V_{DC}} \times 100$$

Voltage regulation: Amounth of the DC ~~voltage~~ output voltage changes over a range of circuit operation.

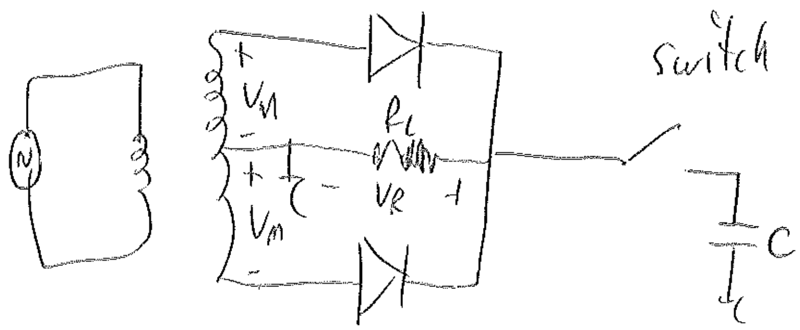
$$\text{Voltage regulation} = \frac{\text{no-load voltage} - \text{full-load voltage}}{\text{full-load voltage}} \times 100$$

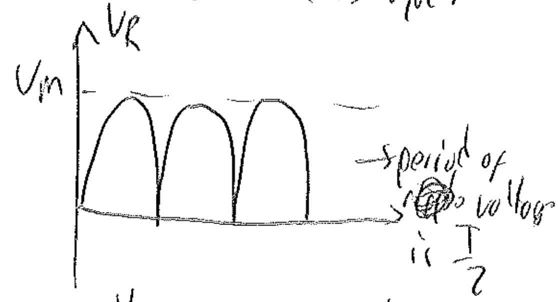
Voltage regulation is best when no-load voltage = full-load voltage

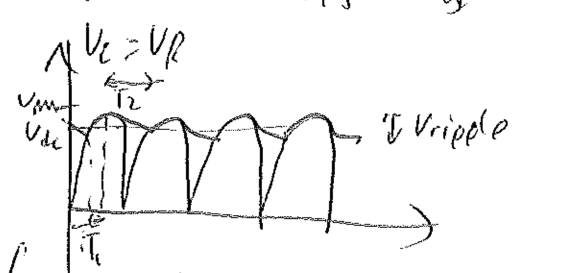
(3) Capacitor filter



Ex:







ripple voltage ← $V_R = \frac{I_{dc}}{4\sqrt{3} f C} = \frac{V_{dc}}{R_L 4\sqrt{3} f C}$

f → frequency

$$V_{DC} = V_m - \frac{V_{DC}}{R 4 f C}$$

$$V_{DC}\left[1 + \frac{1}{4RfC}\right] = V_m$$

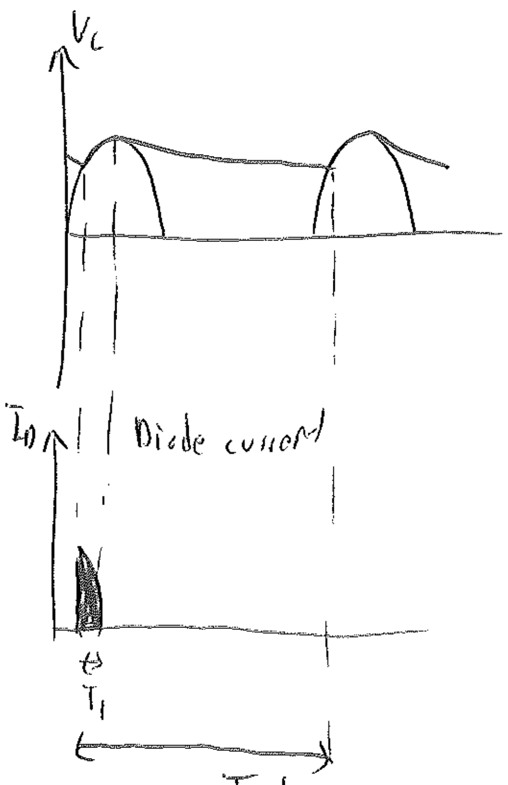
$$V_{DC} = \frac{V_m}{1 + \frac{1}{4RfC}}$$

Filter capacitor ripple

$$r = \frac{V_r(rms)}{V_{DC} \times 4\sqrt{3}} \times 100 = \frac{V_{DC}}{C R_L V_{DC}} \times 100 \times \frac{1}{4\sqrt{3}}$$

Diode conduction period

Diode conducts only in T_1



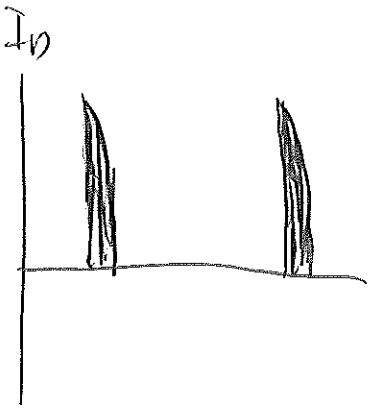
T_1 = diode conduction time

$T = \frac{1}{f}$ period

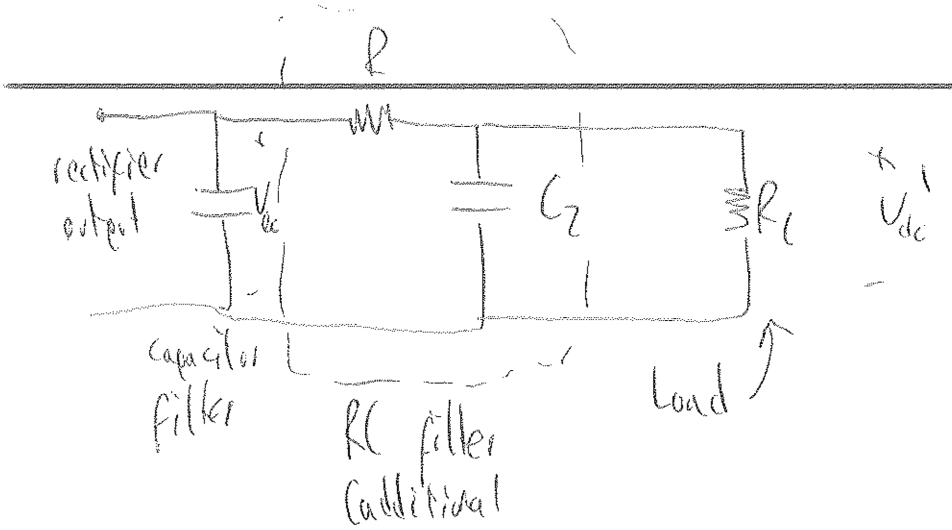
I_{dc} = Average current drawn from filter. $\frac{V_{DC}}{R_L}$

I_{peak} = peak current through the conducting diodes

if $C \uparrow$ I_D increases →

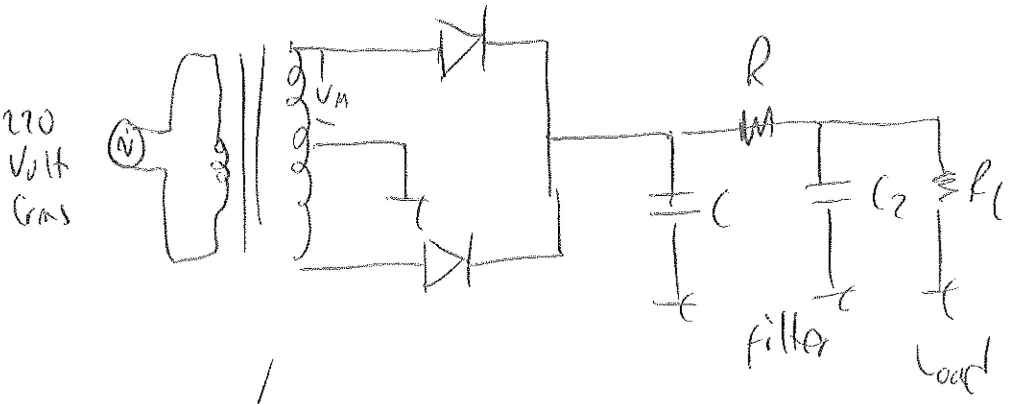


(5) RC filter

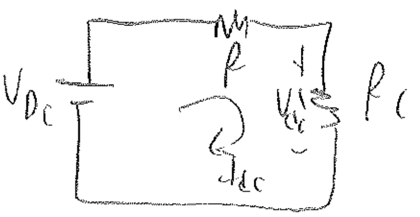


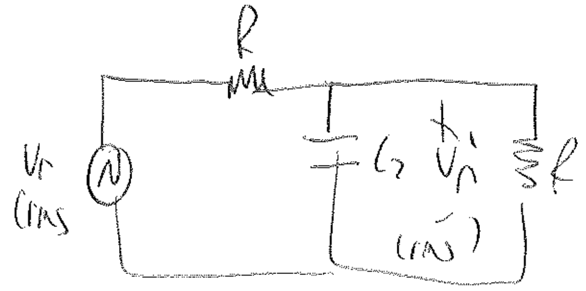
DC operation

$$V'_{dc} = \frac{R_L}{R+R_L} V_{dc}$$



DC equivalent





putting RC_2 filter

$V_r \xrightarrow{\text{drops}} V'_r$

$V_{DC} \xrightarrow{\text{drops}} V'_{DC}$

(both ripple and DC voltage decrease

(6)

$$V_r'(rms) = V_r \times \frac{X_{C_2} // X_{R_L}}{R + X_{C_2} // X_{R_L}} = \frac{\frac{X_{C_2} X_{R_L}}{X_{C_2} + X_{R_L}}}{R + \frac{X_{C_2} X_{R_L}}{X_{C_2} + X_{R_L}}}$$

$X_{R_L} = R_L$

$X_{C_2} = \frac{1}{sC}$

$s = j\omega$

$\omega = 2\pi f$

$$X_{C_2} = \frac{1}{j 2\pi f C} \qquad |X_{C_2}| = \frac{1}{2\pi f C}$$

generally $|X_{C_2}| << X_{R_L}$

hence

$$V_r'(rms) \simeq \frac{X_C}{R} V_r(rms)$$