EEE-2103: Electronic Devices and Circuits

Dept. of Computer Science and Engineering
University of Dhaka

Prof. Sazzad M.S. Imran, PhD
Dept. of Electrical and Electronic Engineering
sazzadmsi.webnode.com

RC and *LC* Power Supply Filters

***RC* π filter:**

Ripple voltage across reservoir capacitor C_1 is attenuated by Additional resistor R_1 and capacitor C_2

π filter = combination of R_1, C_1 and C_2.

C_1 → rectifier output = sawtooth ripple waveform

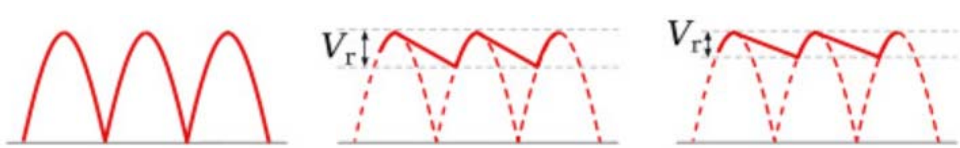
Sawtooth waveform = fundamental ac + smaller-amplitude higher-frequency harmonics

C_2 → filter output = attenuated fundamental component

Peak value of fundamental component →

$v_p = V_r/\pi$

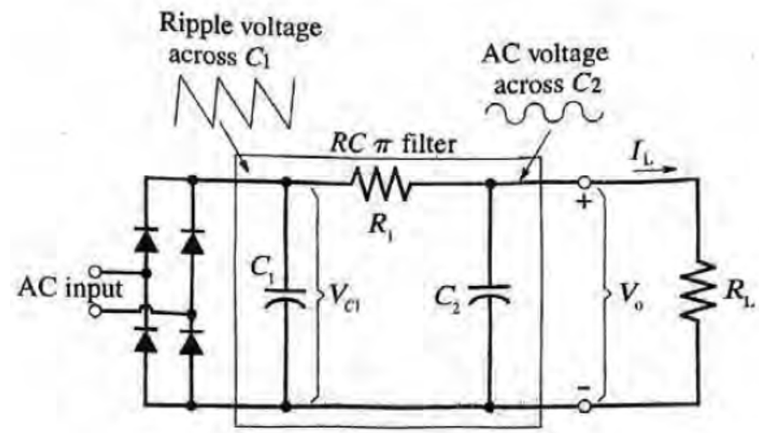
V_r = ripple voltage peak-to-peak amplitude

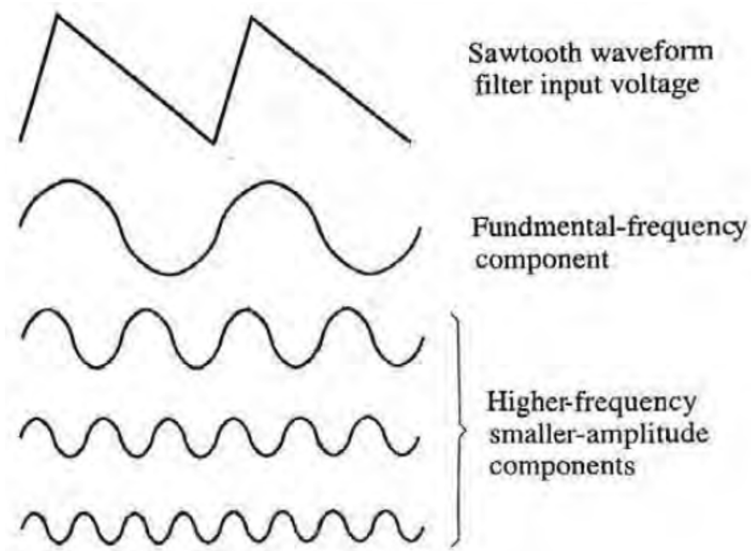


(A) Unfiltered output from rectifier

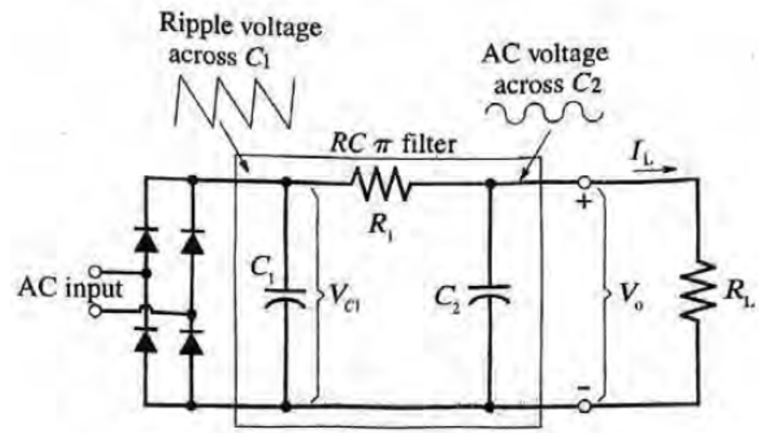
(B) Voltage across capacitor C_1

(C) Voltage across capacitor C_2





RC and *LC* Power Supply Filters



***RC π* filter:**

AC voltage developed across C_2 →

$$v_o = \frac{v_i X_{C2}}{\sqrt{R_1^2 + X_{C2}^2}}$$

v_i = filter ac input voltage applied across C_1

$$X_{C2} = \frac{R_1}{\sqrt{(v_i/v_o)^2 - 1}}$$

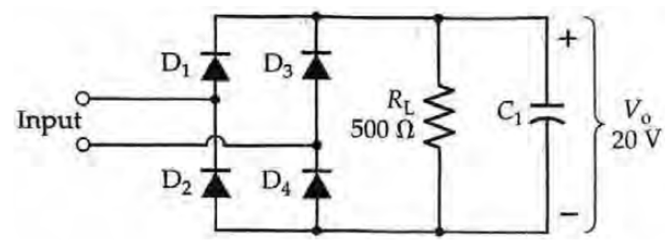
if $(v_i/v_o)^2 >> 1$ →

$$X_{C2} \approx \frac{R_1}{v_i/v_o}$$

RC and *LC* Power Supply Filters

Problem-10:

The 2 V ripple waveform across capacitor C_1 in Fig. 10(a) is to be further attenuated by the use of an additional resistor and capacitor as in Fig. 10(b). If R_1 = 22 Ω, $C_1 = C_2$ = 150 μF and the ac input frequency is 60 Hz, calculate the dc output voltage and the output ripple amplitude.



Load current, $I_L = E_{o(ave)}/R_L = 20/500 = 40$ mA

$V_{o(dc)} = E_{o(ave)} - (I_L R_1) = 20 - (40\times10^{-3}\times22) = 19.12$ V

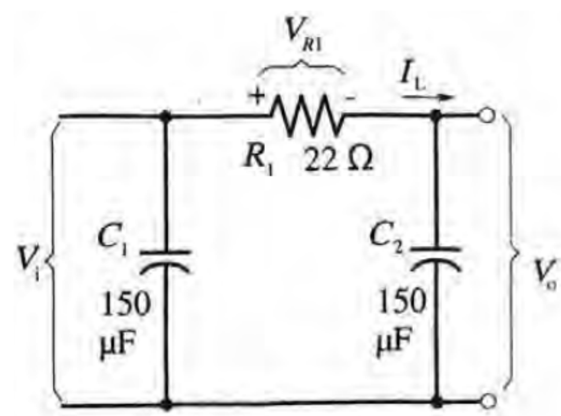
$v_i = v_p = V_r/\pi = 2/\pi = 637$ mV

$X_{C2} = 1/(2\pi f_r C_2) = 1/(2\pi\times(60\times2)\times150\times10^{-6}) = 8.84\ \Omega$

$$v_0 = \frac{v_i X_{C2}}{\sqrt{R_1^2+X_{C2}^2}} = \frac{637\times10^{-3}\times8.84}{\sqrt{22^2+8.84^2}}$$

= 238 mV (peak)

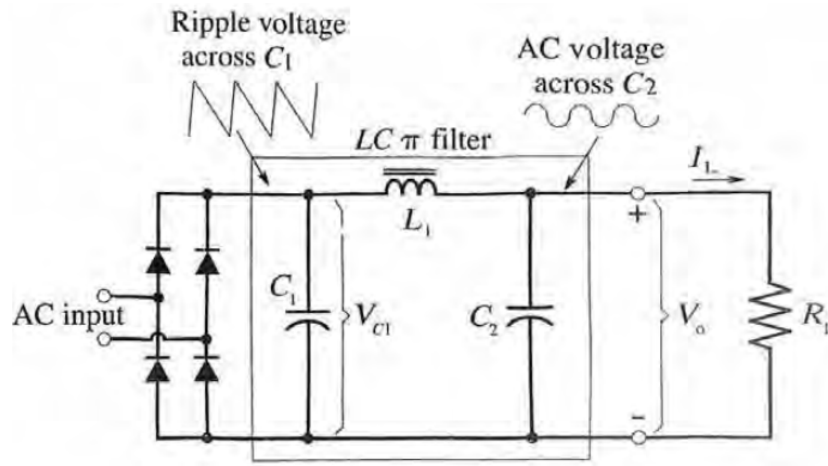
= 476 mV (peak-to-peak)



RC and *LC* Power Supply Filters

***LC* π filter:**

Ripple voltage across reservoir capacitor C_1 is attenuated by
Additional inductor L_1 and capacitor C_2
π filter = combination of L_1, C_1 and C_2.



Assumption → inductor winding resistance, $R_W << X_L$
AC voltage across C_2 →

$$v_0 = \frac{v_i X_{C2}}{X_{L1} - X_{C2}}$$

From above equation →

$$X_{L1} = X_{C2}\left(\frac{v_i}{v_0} + 1\right)$$

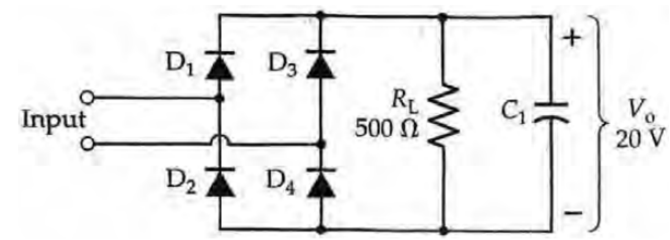
Design steps →

Select $C_1 = C_2$
Calculate L_1

RC and *LC* Power Supply Filters

Problem-11:

The 2 V ripple waveform across capacitor C_1 in Fig. 11(a) is to be further attenuated by a factor of approximately 4 by the use of an additional inductor and capacitor as in Fig. 11(b). If C_1 = 150 μF and the ac input frequency is 60 Hz, determine suitable values for L_1 and C_2.



Select $C_2 = C_1 = 150\ \mu F$

$X_{L1} = X_{C2}\left(\frac{v_i}{v_0} + 1\right) = X_{C2}(4/1+1) = 5X_{C2}$

$X_{C2} = 1/(2\pi f_r C_2) = 1/(2\pi\times(60\times2)\times150\times10^{-6}) = 8.84\ \Omega$

$L_1 = 5X_{C2}/(2\pi f_r) = 5\times8.84/(2\pi\times120) \approx 59$ mH