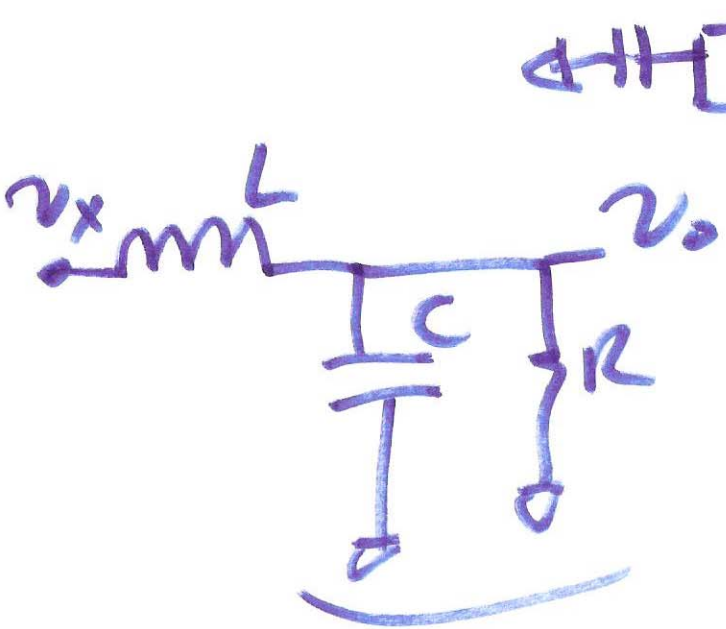
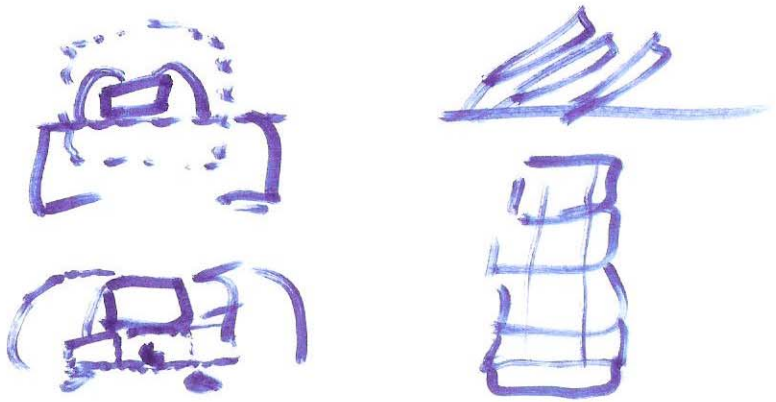
ECE 5/472 Power Electronics

BOISE STATE UNIVERSITY

Lecture 16, OCT. 18, 2011





$$\frac{\frac{R}{1+sRC}}{\frac{R}{1+sRC} + sL}$$

$$\frac{v_o}{v_x} = \frac{\frac{R}{1+sRC}}{\frac{R}{1+sRC} + sL}$$

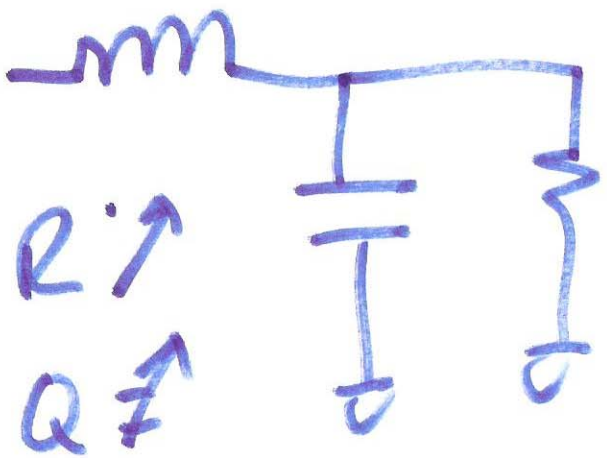
$$\frac{\omega_0}{Q} = \frac{1}{RC} \qquad \omega_0^2 = \frac{1}{LC}$$

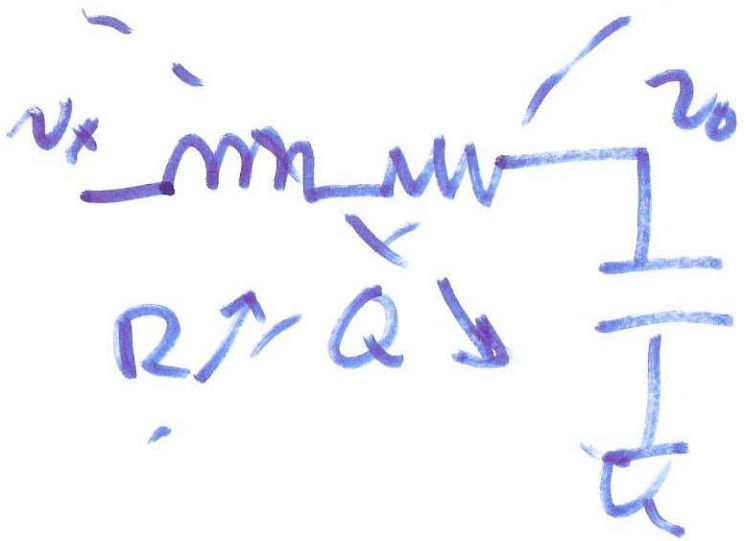
$$\frac{\frac{1}{LC}}{s^2 + s\frac{1}{RC} + \frac{1}{LC}} = \frac{R}{s^2RCL + sL + R}$$

1)

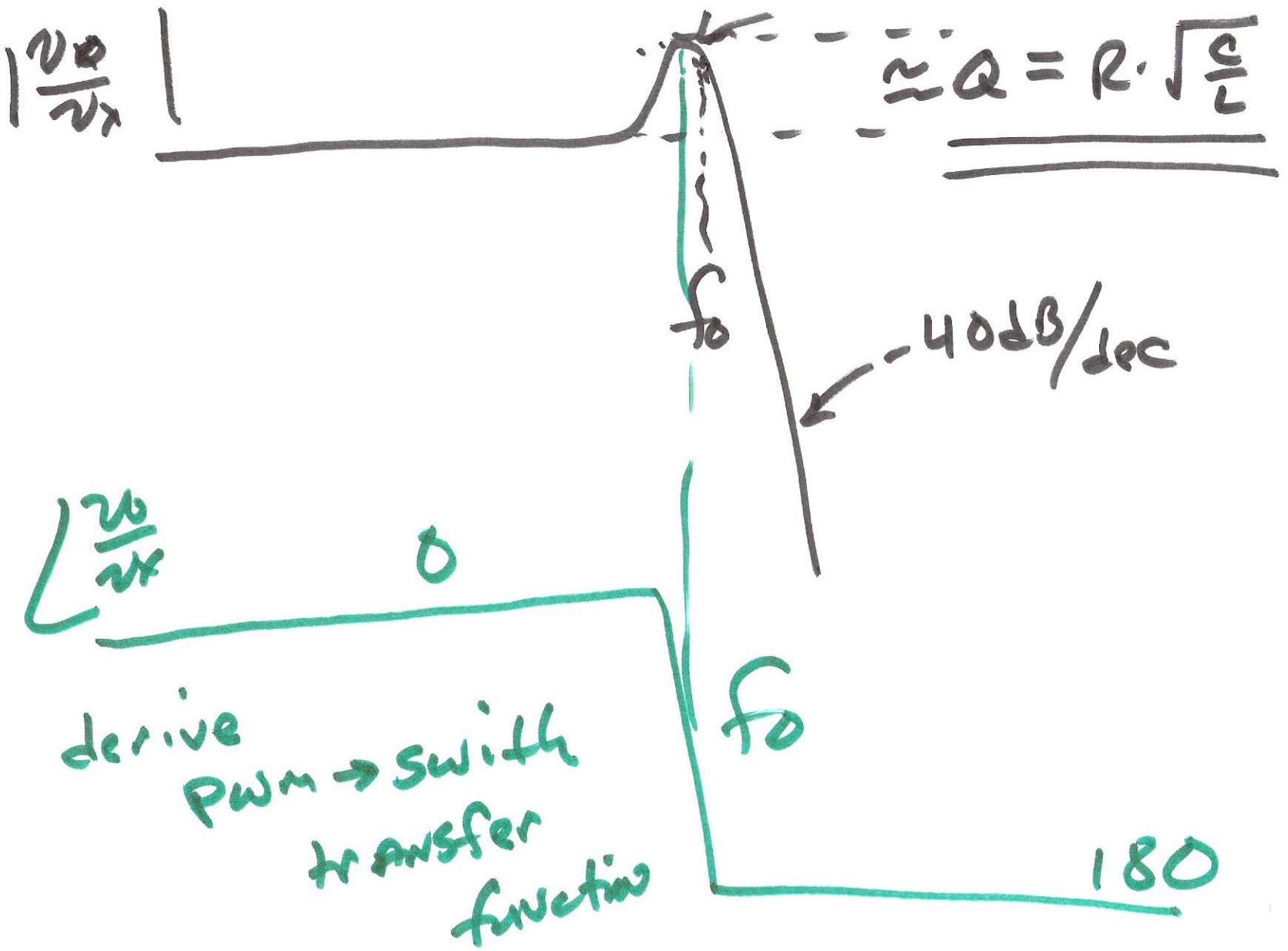
$$f_0 = \frac{1}{2\pi\sqrt{LC}} \qquad \frac{2\pi f_0}{Q} = \frac{1}{RC}$$

$$Q = \frac{2\pi RC}{2\pi\sqrt{LC}} = R\cdot\sqrt{\frac{C}{L}}$$

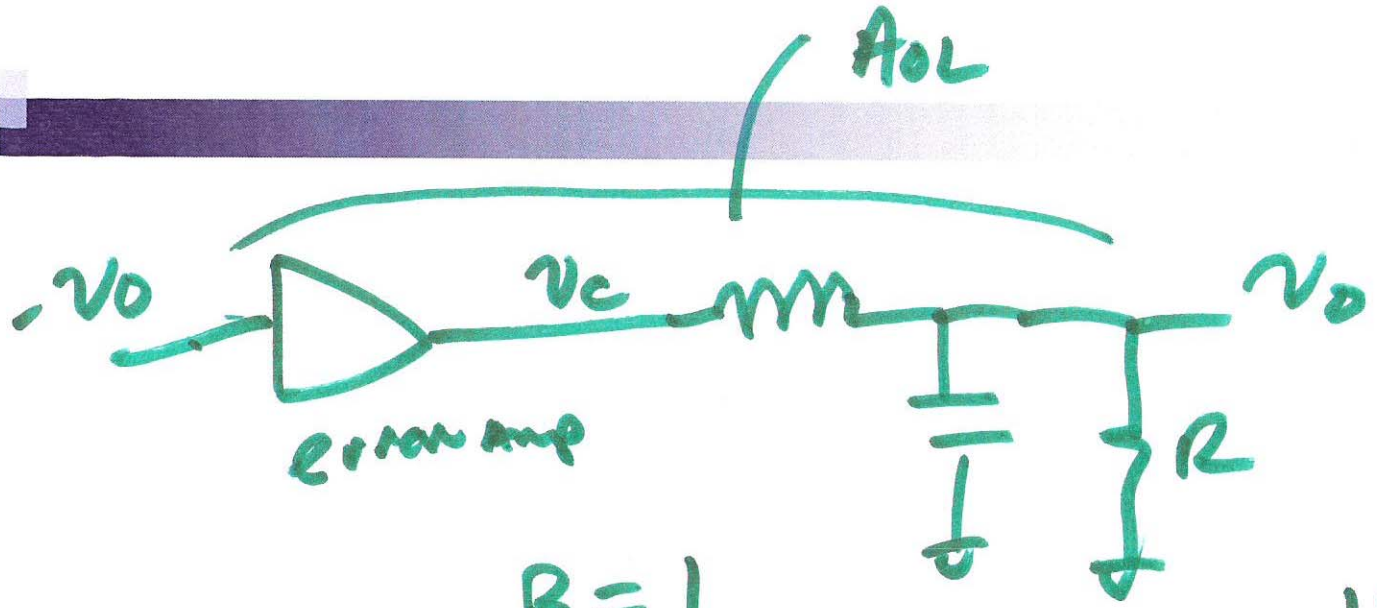




2)


$\left|\frac{v_o}{v_i}\right|$
$\simeq Q = R \cdot \sqrt{\frac{C}{L}}$
f_0
-40dB/dec
$\angle\frac{v_o}{v_i}$
0
f_0
180
derive
PWM → switch
transfer
function

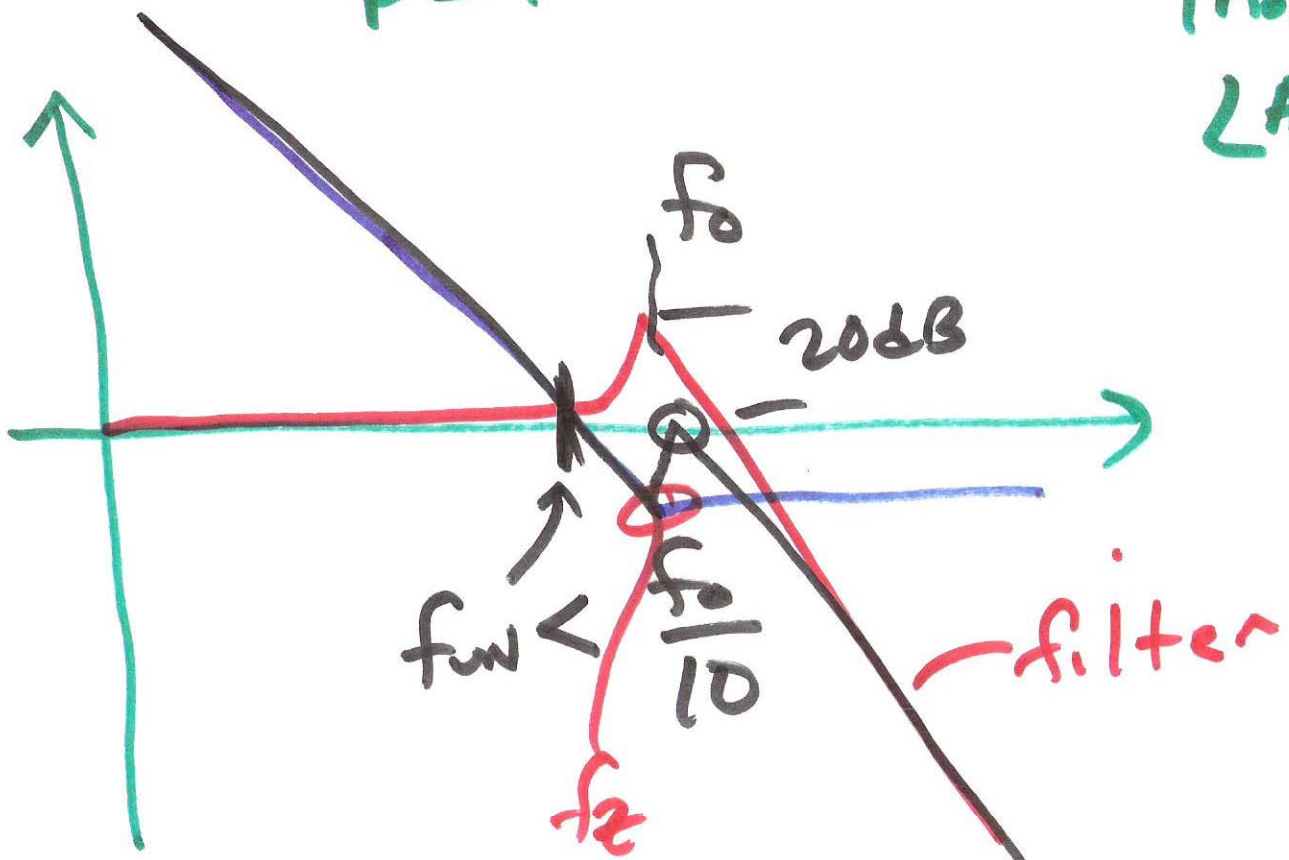
3)



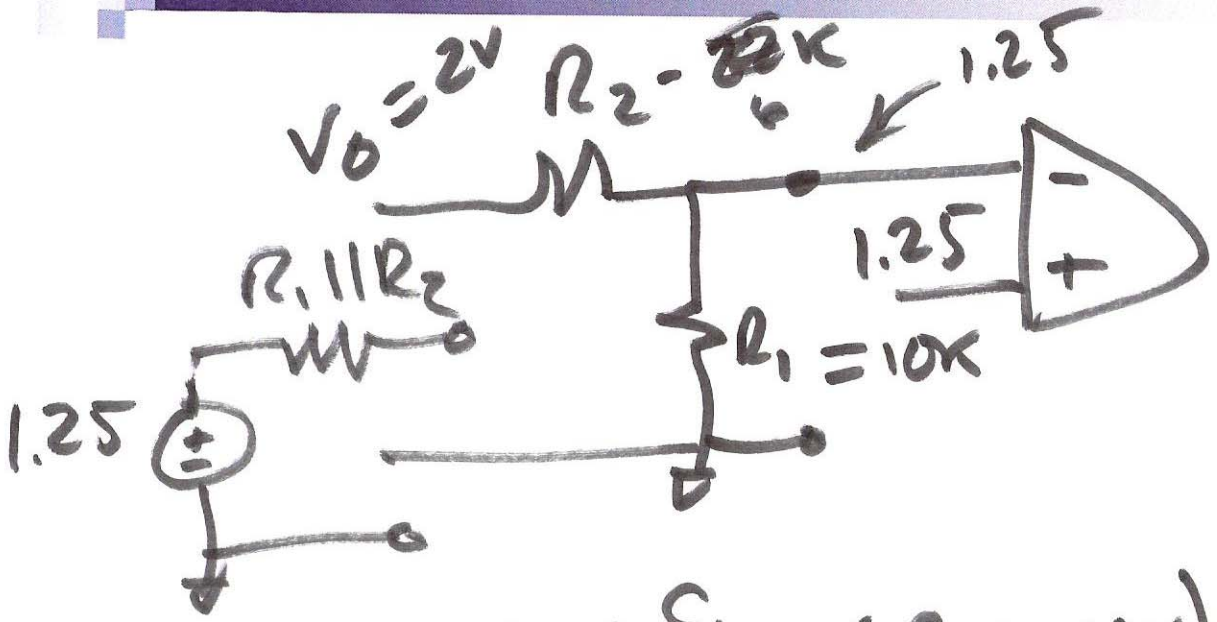
$\beta = 1$

$|A_{OL}| = 1$

$\angle A_{OL} = \pm 180°$



4)

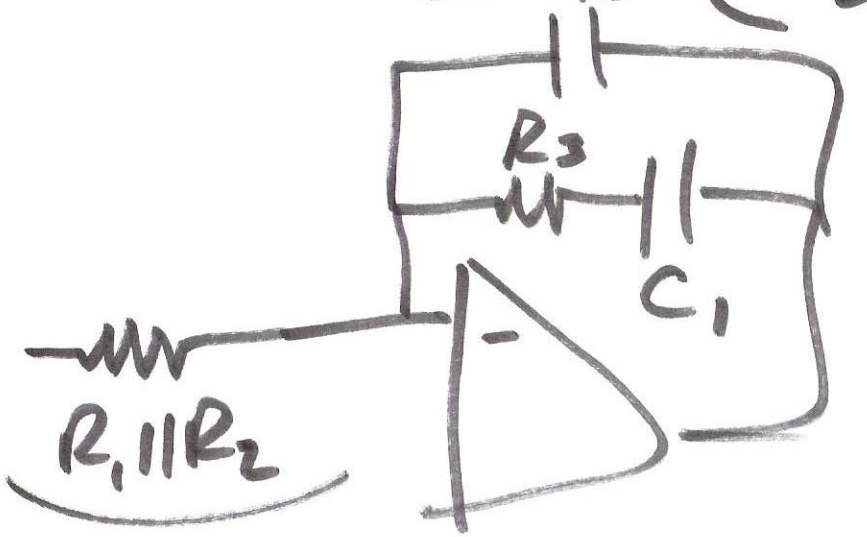


$$1.25 = 2 \cdot \frac{R_1}{R_1 + R_2}$$

$$(R_2 + 10K)\frac{1.25}{2} = 10K$$

$$R_2 = \frac{20K}{1.25} - 10K$$

$$R_2 = 6K$$



5)

$$f_0 = \frac{1}{2\pi\sqrt{10^{-6}\cdot 10^{-6}}} = \frac{1}{2\pi}\cdot 10^6 = 159\,kHz$$

$$Q = R\cdot\sqrt{\frac{C}{L}} = 5$$

$f_{un} \le \frac{1}{10} f_0$ rule #1

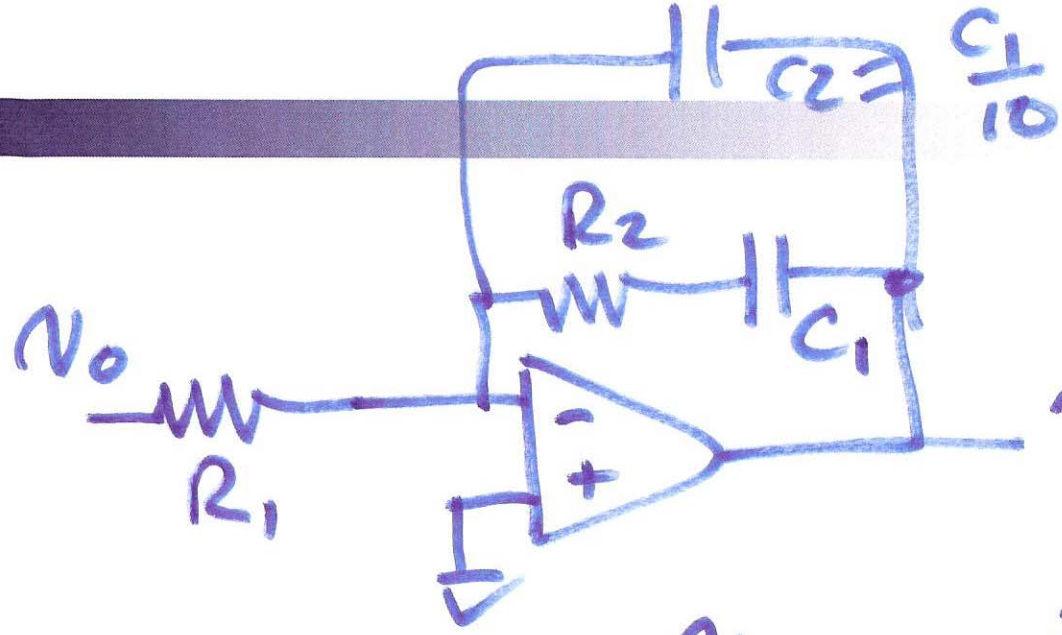
$f_{un} \le 15.9\,kHz$ $f_{un} = 15.9\,kHz$

$f_z = ?$ rule #2

$f_z \le f_0$ $f_z = 159\,kHz$

$f_{un} \le \frac{f_z}{10}$ rule #3

(b)



$$f_{cW} = \frac{1}{2\pi R_1 C_1}$$

$C_2 = .1\mu F$

$$\frac{V_c}{V_o} = \frac{\frac{1}{sC_1} + R_2}{R_1} = \frac{1 + sC_1R_2}{sR_1C_1}$$

$f_{cW} \rightarrow \left|\frac{V_c}{V_o}\right| = \left| \simeq \frac{1}{\sqrt{0^2 + (2\pi f_{cW} R_1 C)^2}} \right|$

$f_z >> f_{cW}$

$$f_z = \frac{1}{2\pi R_2 C_1}$$

7)

$$\frac{1}{\sqrt{0^2 + (2\pi f_w \cdot R_1 C_1)^2}} = 1 = \left| \frac{v_c}{v_o} \right|$$

$$f_w = \frac{1}{2\pi R_1 C_1}$$

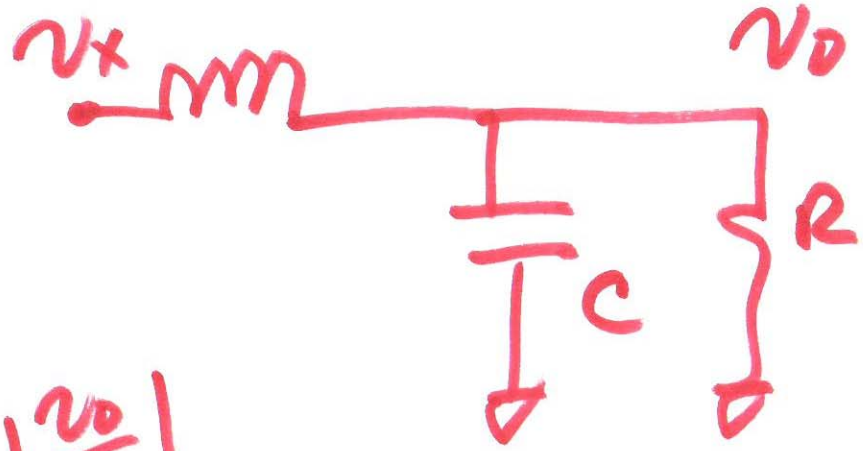
$$f_z = \frac{1}{2\pi R_2 C_1} = 159\,KHz$$

$$R_2 = \underline{\underline{37.5K}}$$

$$f_w = 15.9\,KHz = \frac{1}{2\pi \cdot 3.75K \cdot C_1}$$

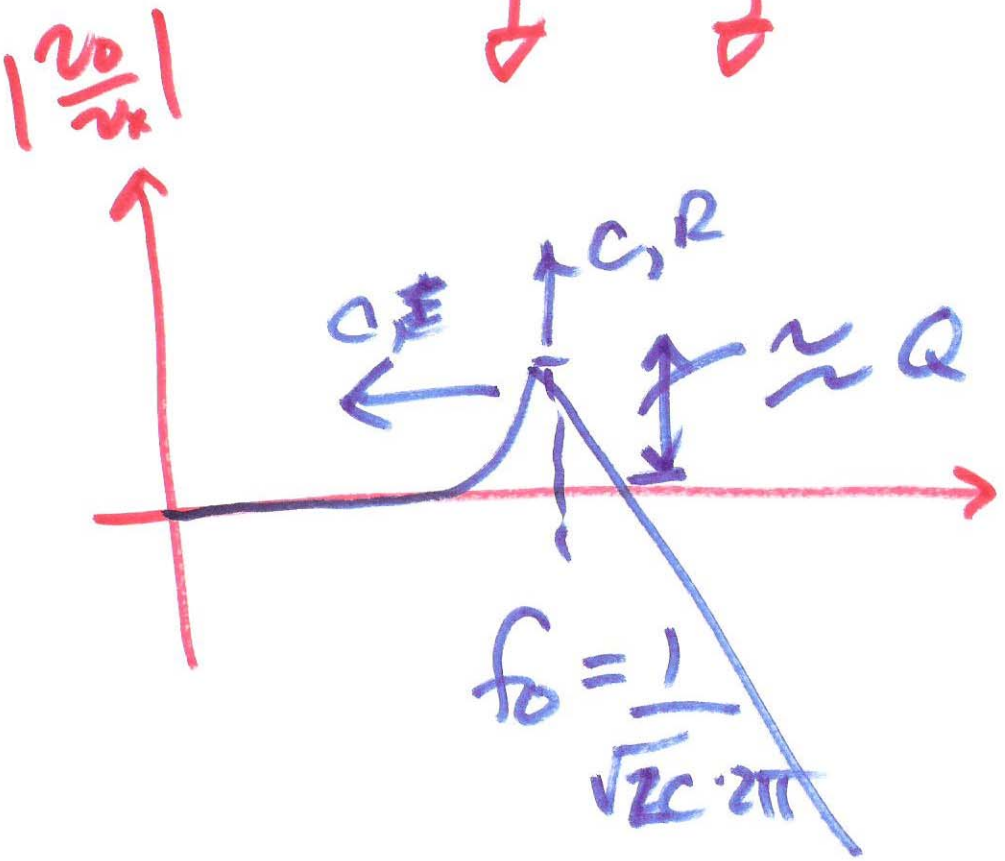
$$C_1 = 2.67NF, C_2 = .267NF$$

8)

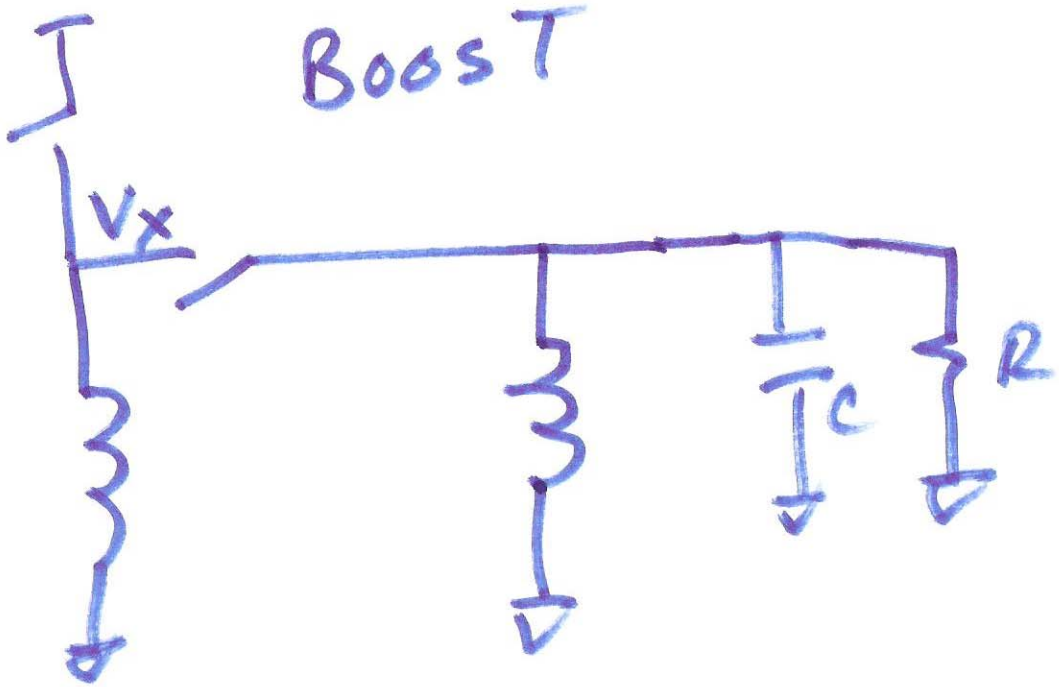


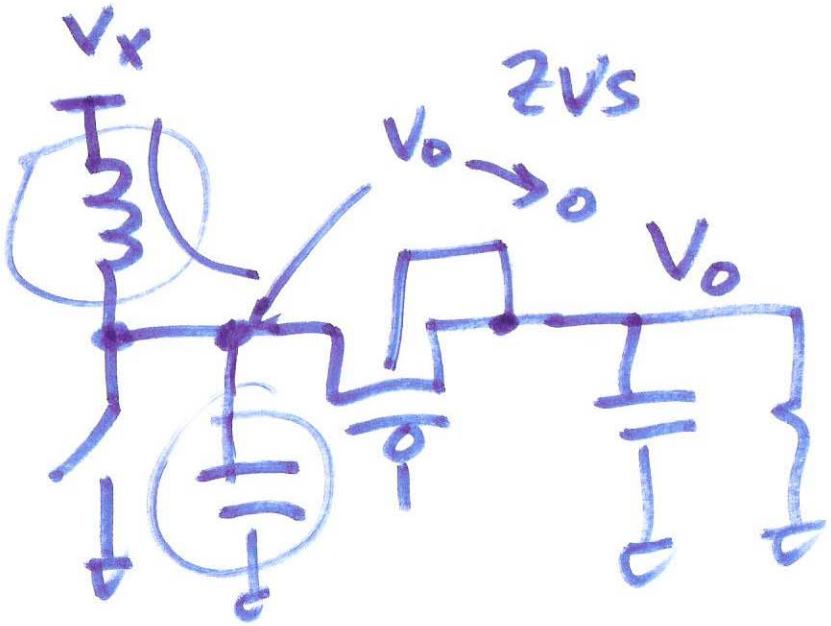
$$Q = R \cdot \sqrt{\frac{C}{L}}$$

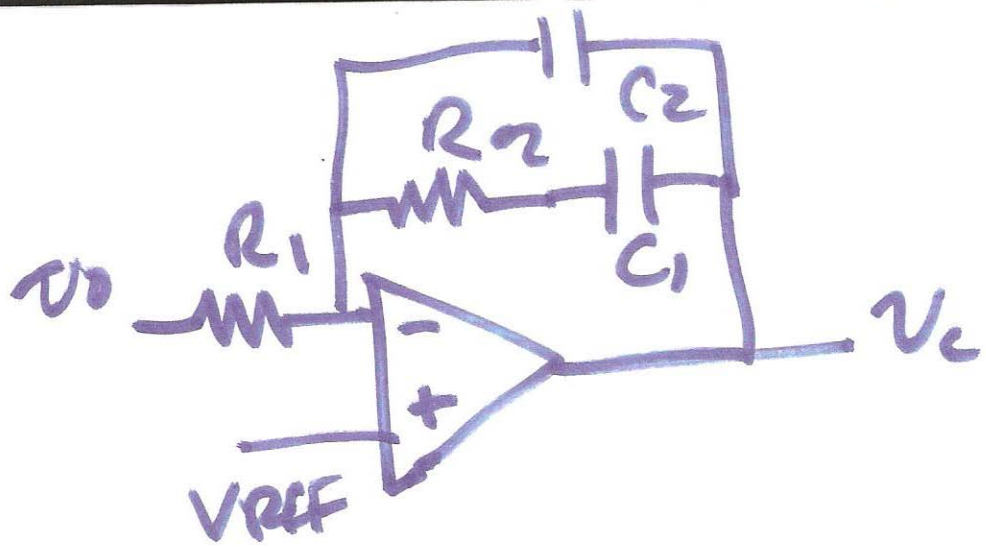
$R_{Load-min}$



9)


Boost
Vx
C
R


Vx
ZVS
Vo
0
Vo



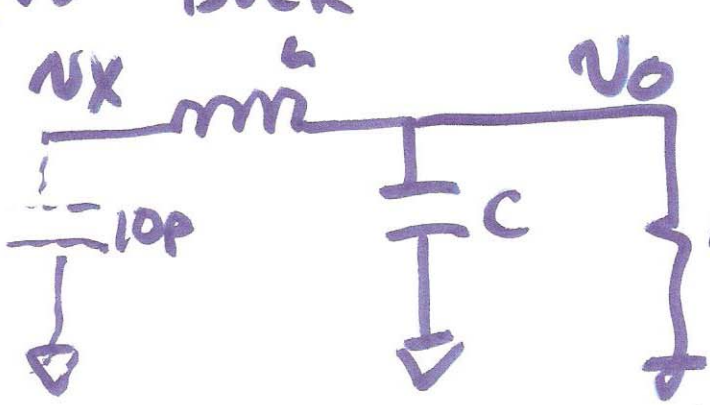
$$C_2 = \frac{C_1}{10}$$

$$\frac{V_c}{-V_o} = + \frac{1 + 5C_1R_2}{5R_1C_1}$$

Assuming → Rules are valid

$$f_w = \frac{1}{2\pi R_1 C_1}, \quad f_z = \frac{1}{2\pi R_2 C_1}$$

ZVS Buck



$f_o = \frac{1}{2\pi\sqrt{LC}}$

$Q = R\cdot\sqrt{\frac{C}{L}}$

Assume:

1) f_o << switching freq.

2) ACTIVE PI (TYPE II) loop filter

Rule #1

$f_{sw} \leq \frac{f_o}{10}$

Rule #2

$f_z \leq f_o$

Rule #3

$f_{sw} \leq \frac{f_z}{10}$

$\frac{1}{2}C_1$