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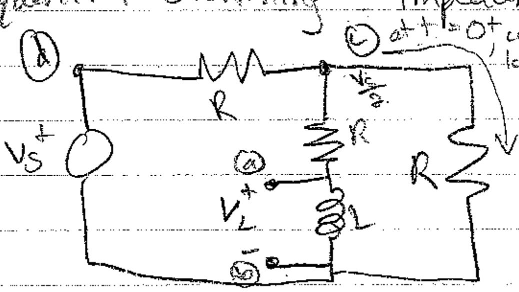
Exam 2 Review

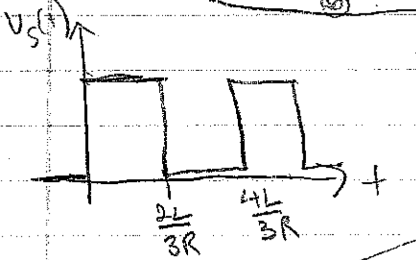
Ch. 5 Op Amps
Ch 6 L, C (not 6.4, 6.5)
Ch 7 First order, homogeneous & particular w/DC sources
★ Impedance Z(s) to find homogeneous response

Remove V_S $V_S = 0$ S.C.
Remove I_S $I_S = 0$ O.C.

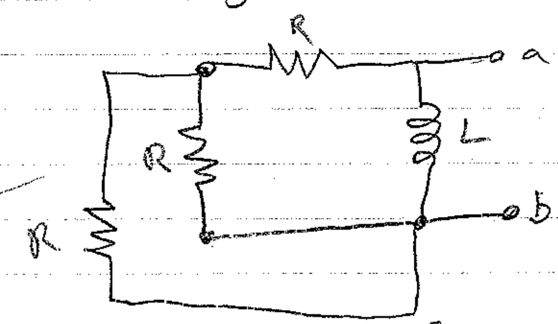
Sequential Switching + impedance

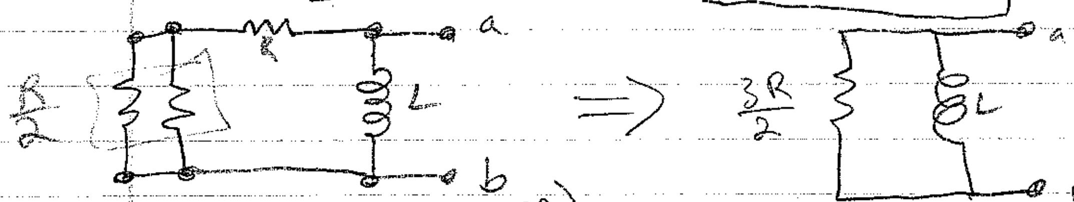


Find $v_L(t)$ if all $i, v = 0$ @ $t=0$



$V_S \rightarrow$ S.C.





$$Z(s) = \frac{sL\left(\frac{3R}{2}\right)}{sL + \frac{3R}{2}} = \frac{sL(3R)}{2sL + 3R}$$

$sL(3R)$ ← zero used for current
$2sL+3R$ ← poles used for voltage

$$\boxed{s = \frac{-3R}{2L}}$$

$$V_{Lh} = Ae^{-\frac{3R}{2L}t}$$

$$V_L = V_{LH} + V_{LP} = Ae^{-\frac{3R}{2L}t} + 0 \qquad V_L(0^+) = A = \frac{V_S}{2}$$

$$\Rightarrow \boxed{V_L = \frac{V_S}{2}e^{-\frac{3R}{2L}t}} \quad 0 < t < \frac{2L}{3R}$$

Cover page

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Ch. 5 Op Amps

Ch. 6 L, C (not 6.4, 6.5)

Ch. 7 First Order, Homogeneous & particular w/ dc sources

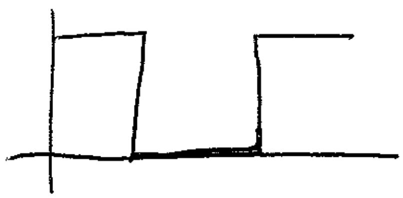
Sequential switching, impedance $Z(s)$ to find homogeneous response

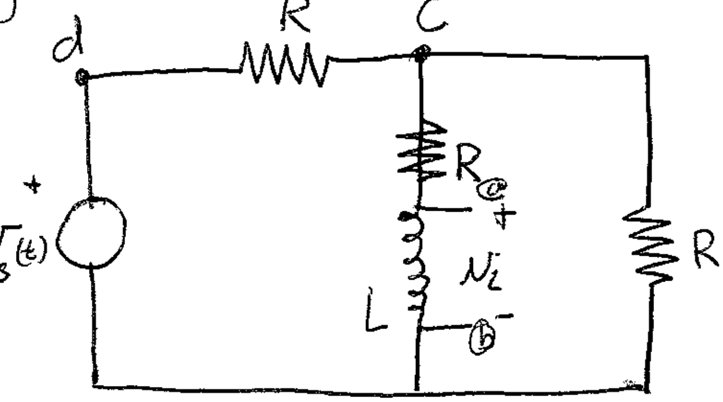
Complex numbers

Remove V_s $V_s = 0 \Rightarrow$ short circuit

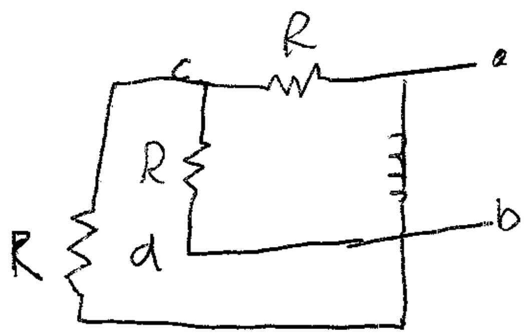
I_s $I_s = 0 \Rightarrow$ open circuit

Sequential switching + impedance

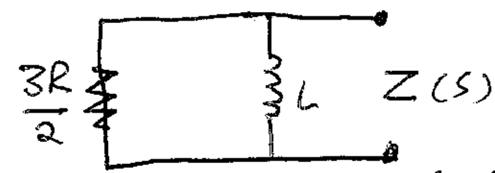




Find $v_L(t)$ if all $i\,v = 0$ (no energy storage) @ $t = 0^-$



$\Rightarrow$



$$Z(s) = \frac{sL\left(\frac{3R}{2}\right)}{sL + \frac{3R}{2}} = \frac{sL(3R)}{2sL + 3R}$$

$$V_L = V_{Lh} + v_{Lp}$$

$$V_{Lh} = Ae^{\left(-\frac{3R}{2L}\right)t} + 0$$

for A, $i = \frac{V_s}{2R}$ (all goes around outside loop; no current → L)

$iR = \frac{V_s}{2}$

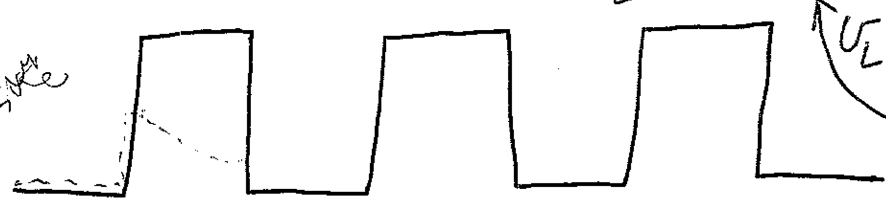
$$V_L(0^+) = A = \frac{V_s}{2}$$

$$\therefore \boxed{V_L(t) = \frac{V_s}{2} e^{\left(-\frac{3R}{2L}\right)t}} \; V \quad \Big| \; 0 \le t \le \frac{2L}{3R}$$

$$V_L(t) = B e^{\left(-3R/2L\right)\left(t - \frac{2L}{3R}\right)} \quad \frac{2L}{3R} < t < \frac{4L}{3R}$$

$V_L(0^+) = B = ?$

$$\left(-\frac{V_s}{2} e^{-1}\right)$$



$v_L = L\frac{di}{dt}$ @

$$V_L = \left(\frac{V_s}{2} e^{-1}\right) e^{-\frac{3R}{2L}t}$$

v_{Lh}

v_{Lh}

<u>Op Amps</u>

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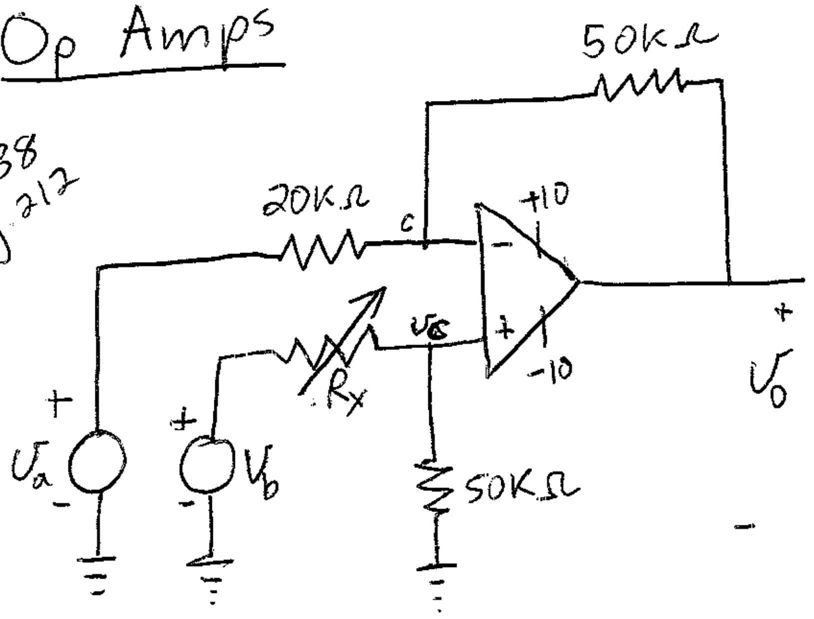


Find R_x for CMRR ≥ 1000 (2)

$$CMRR = \left|\frac{A_{dm}}{A_{cm}}\right|$$

$$v_{dm} = v_b - v_a$$

$$v_{cm} = \frac{1}{2}(v_a + v_b)$$

$$v_o = A_{cm}v_{cm} + A_{dm}v_{dm}$$

$$v_c = \frac{50k}{R_x + 50k} v_b$$

$$\sum_c i = \left[\frac{v_a - v_c}{20k} + \frac{v_o - v_c}{50k} = 0\right]100 = 5\left[v_a - \frac{50k}{50k+R_x}v_b\right] + 2\left[v_o - \frac{50k}{50k+R_x}v_b\right] = 0$$

$$v_o = \frac{-5(50k+R_x)v_a + 5(50k)v_b + 2(50k)v_b}{2(50k+R_x)}$$

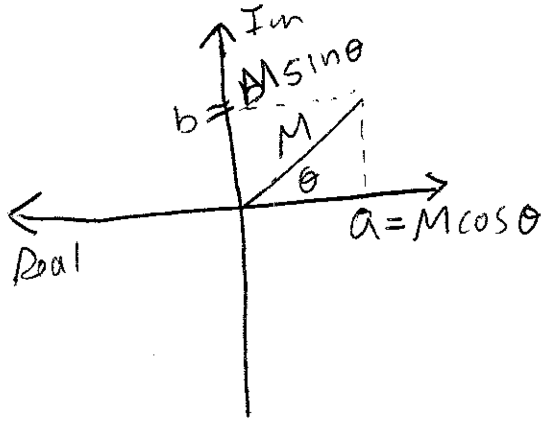
need $v_o = A_{cm}v_{cm} + A_{dm}v_{dm}$

use $\left\{ \begin{array}{l} v_a = \text{fn of } v_{dm} + v_{cm} \\ v_b = \text{fn of } v_{dm} + v_{cm} \end{array} \right\}$ plug into

to Obtain

Complex Numbers

Rect $a+jb$ Polar $Me^{j\theta} = M\angle\theta$



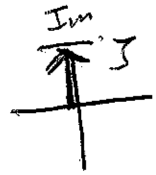
Prefer

Add / Subtract (rect)

Multiply / Divide (Polar)

Powers / Roots (Polar)

Roots

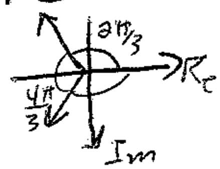


$\sqrt{j}$ $\begin{cases} a+jb \\ a=0,\ b=1 \end{cases}$

$= e^{j\pi/2} \rightarrow \sqrt[2]{j} = \sqrt[2]{e^{j\pi/2}} = 1e^{j\pi/4},\ 1e^{j\frac{5\pi}{4}}$

$\sqrt[N]{Me^{j\theta}} = M^{1/N}e^{j\theta/N},\ M^{1/N}e^{j(\theta+2\pi)/N}$

$\sqrt[3]{1} = \sqrt[3]{1\angle 0} = \sqrt[3]{1e^{j0}} = 1e^{j(0)/3}$



Complex Conjugate

$j \rightarrow -j$

$C^* = Me^{-j\theta} = a - jb$ | $M = \sqrt{a^2+b^2}$

$C = Me^{j\theta} = a + jb$ | $\theta = \tan^{-1}\left(\frac{b}{a}\right)$

$(C)(C^*) = M^2 \neq C^2$