LECTURE 4 6-26-09

MIT OSCILLATOR VIDEO

$$x \longrightarrow \hat{x}\, e^{i\omega t}$$

$x(t)$ — TIME SPACE

$\hat{x}(\omega) \cdot e^{i\omega t}$ — FREQUENCY

COEFF SPACE ← depends on ω

~~CMO~~
CAN DO EXACTLY THE SAME THING FOR SPACE

$$r(z) \longrightarrow \hat{r}\, e^{ikx}$$

POSITION SPACE

COEFF ← depends on k

SPATIAL FREQUENCY SPACE

TEMPORAL FREQUENCY

CAN ALSO DO BOTH

$$f(z,t) \longrightarrow \hat{f}\, e^{ikz} e^{i\omega t}$$

COEFF depends on k and ω

$x \rightarrow \hat{x} e^{i\omega t}$

CONVERTED $F = ma$ DIFF EQN $\Longrightarrow$ ALGEBRAIC EQN

FOR THE STEADY STATE SOLUTIONS!

WE SAW YESTERDAY THAT THERE ARE TRANSIENTS.

FEYNMAN I-24 SHOWS HOW TO DO TRANSIENTS

TODAY I WANT TO SHOW YOU HOW TO USE $V(t) \rightarrow \hat{V} e^{i\omega t}$ TO SOLVE STEADY STATE ELECTRICAL CIRCUITS

http://en.wikipedia.org/wiki/Harmonic_oscillator

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/accircon.html#c1

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/watcir2.html#c1

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/acohml.html#c1

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/imped.html#c1

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/acres.html#c1

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/accap.html#c2

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/acind.html#c2

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/accircon.html#c1

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/phase.html#c1

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/phase.html#c2

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/impcom.html#c1

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/phase.html#c3

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/accircon.html#c1

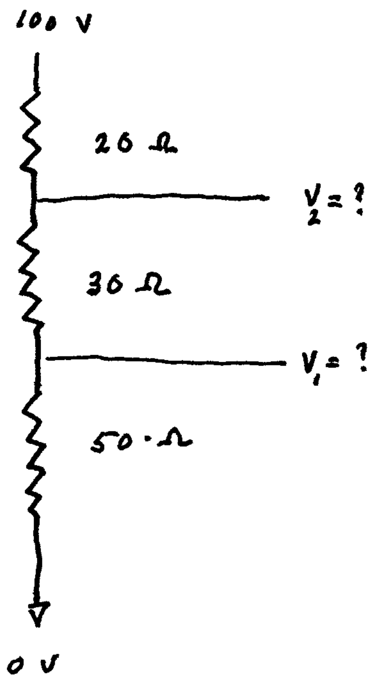
http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/serres.html#c1

Applets

http://qbx6.ltu.edu/s_schneider/physlets/main/rlc.shtml

http://mysite.verizon.net/vzeoacw1/impedance.html

IDEA:



$$R_T = 50 + 30 + 20 = 100\ \Omega$$

$$V_1 = \frac{50}{100}(100\text{V}) = 50\ \text{V}$$

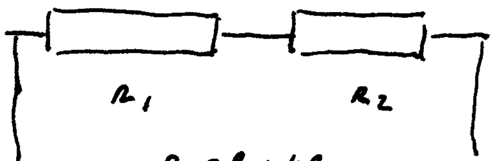
$$V_2 = \frac{50+30}{100}(100\ \text{V}) = 80\ \text{V}$$

CALLED A RESISTIVE DIVIDER

GENERALIZE	RESISTIVE DIVIDER	$\Longrightarrow$	IMPEDANCE DIVIDER
	R		Z
	resistance		impedance
	$V = i\,R$		$\hat{V} = \hat{i}\,\hat{Z}$
	RESISTORS		RESISTORS CAPACITORS INDUCTORS

COMBINING COMPONENTS:

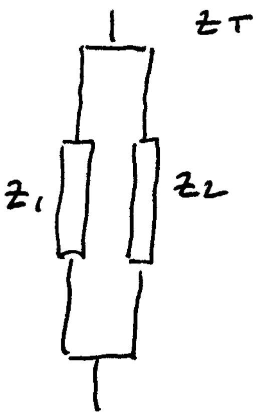
SERIES



$$R_T = R_1 + R_2$$

$$Z_T = Z_1 + Z_2$$

PARALLEL

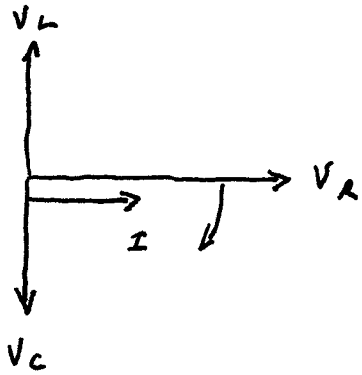


~~(Z_T)~~

$$\frac{1}{Z_T} = \frac{1}{Z_1} + \frac{1}{Z_2}$$

$$\frac{1}{Z_T} = \frac{Z_2 + Z_1}{Z_1 Z_2}$$

$$Z_T = \frac{Z_1\, Z_2}{Z_1 + Z_2}$$



$V = I R$

$V = I Z$

$Z_R = R$

$Z_L = i \omega L$

$Z_C = \frac{1}{i \omega C}$

V_C LEADS I BY 90°

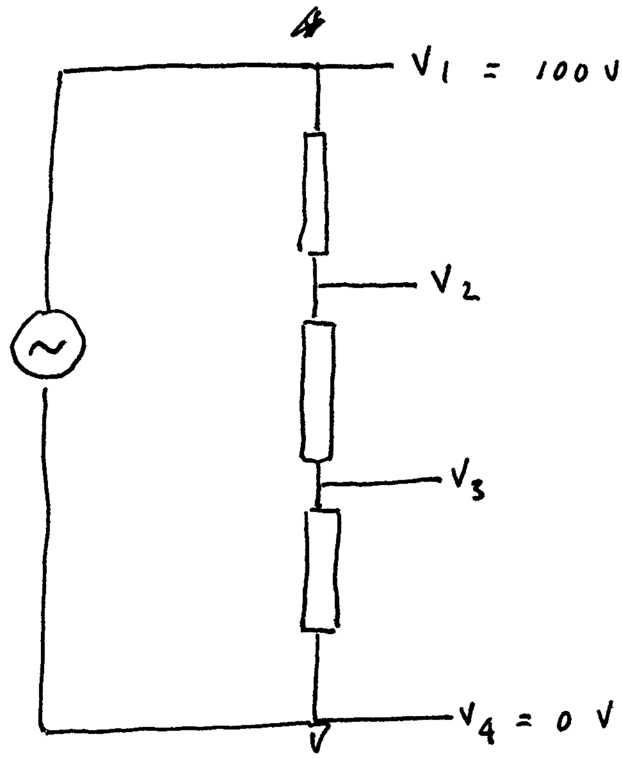
V_L LAGS I BY 90°

V_R SYNC W I

ELI the ICE man

E – VOLTAGE, L – INDUCTOR, I – CURRENT; I – CURRENT, C – CAPACITOR, E – VOLTAGE

Z DIVIDER



$V = i R_T$

$R_T = R_1 + R_2 + R_3$

$V_3 = \frac{R_3}{R_T} V_0$

~~$i = \frac{V}{R_T}$~~

$V_2 = \frac{R_2 + R_3}{Z_T} V_0$

$V = i Z_T$

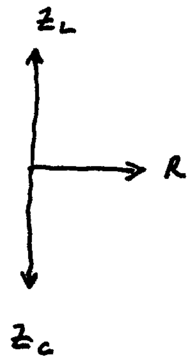
$Z_T = Z_1 + Z_2 + Z_3$

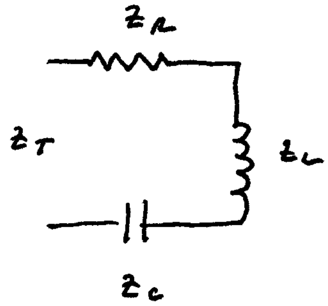
$$V_3 = \frac{Z_3}{Z_T} V_0$$

$$V_2 = \frac{Z_2 + Z_3}{Z_T} V_0$$

RESONANCE IN RLC CIRCUITS

SERIES





$Z_L + Z_C = 0$ CANCEL

$Z_T = R$

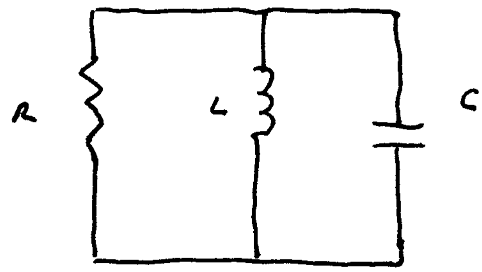
MINIMUM IMPEDANCE AT RESONANCE

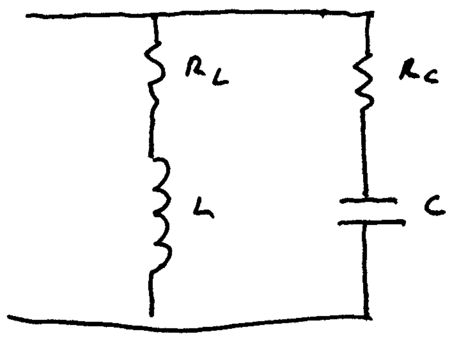
$|Z_L| = |Z_C|$

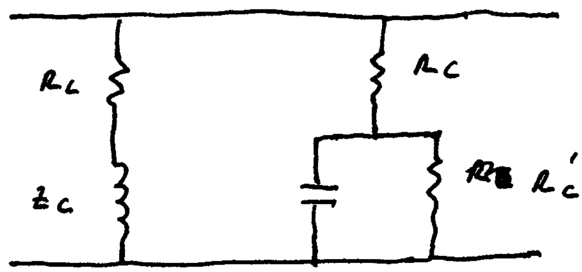
$$\omega L = \frac{1}{\omega C}$$

$$\omega^2 = \frac{1}{LC}$$

PARALLEL







MAXIMUM IMPEDANCE AT RESONANCE

in limit as $R_L, R_C, R_C' \to 0$

$$\omega_0^2 = \frac{1}{LC}$$