Circuit Analysis : ECED 2001 — Lecture 3

Recall:

$$V(t) = V_m \cos(\omega + \phi)$$

Max Phasor Domain

$$V = V_m \angle \phi$$

RMS Phasor Domain

$$V = \frac{V_m}{\sqrt{2}}$$

Only true for Sin and Cos waves! Other RMS waves must use general RMS

- When representing items in the phasor domain, all laws such as KVL, KCL, Thev, Nodal, all still work.

Step one

Transform Sinusoids into phasors

Step Two

Do arithmetic on phasors

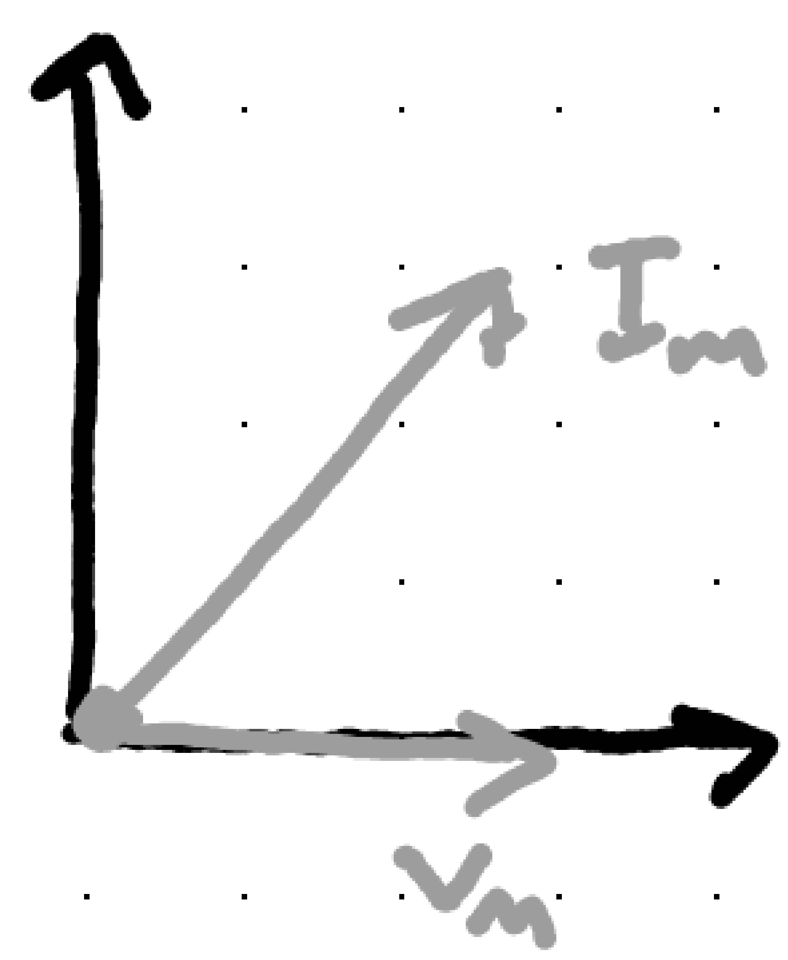
Step Three

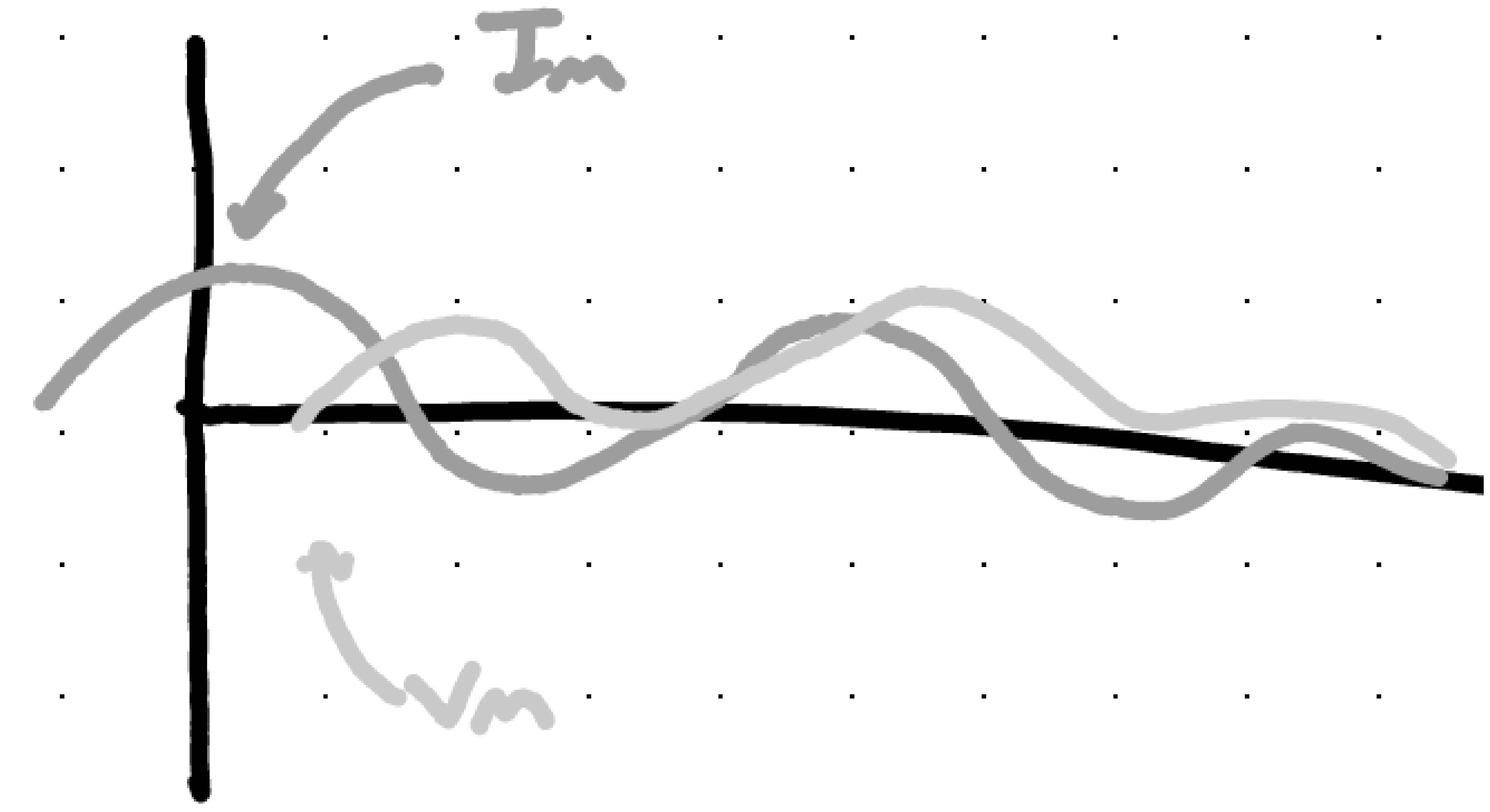
Remember to transform back!

- When converting to RMS, you should be using Cos. It's not wrong to do that do so, but good practice. Also, all functions must be one or the other. No mixing.

$$\sin(\omega t + 45^\circ) \rightarrow \cos(\omega t + 45^\circ - 90^\circ)$$

In Phasor, you can tell who is leading by the angle.



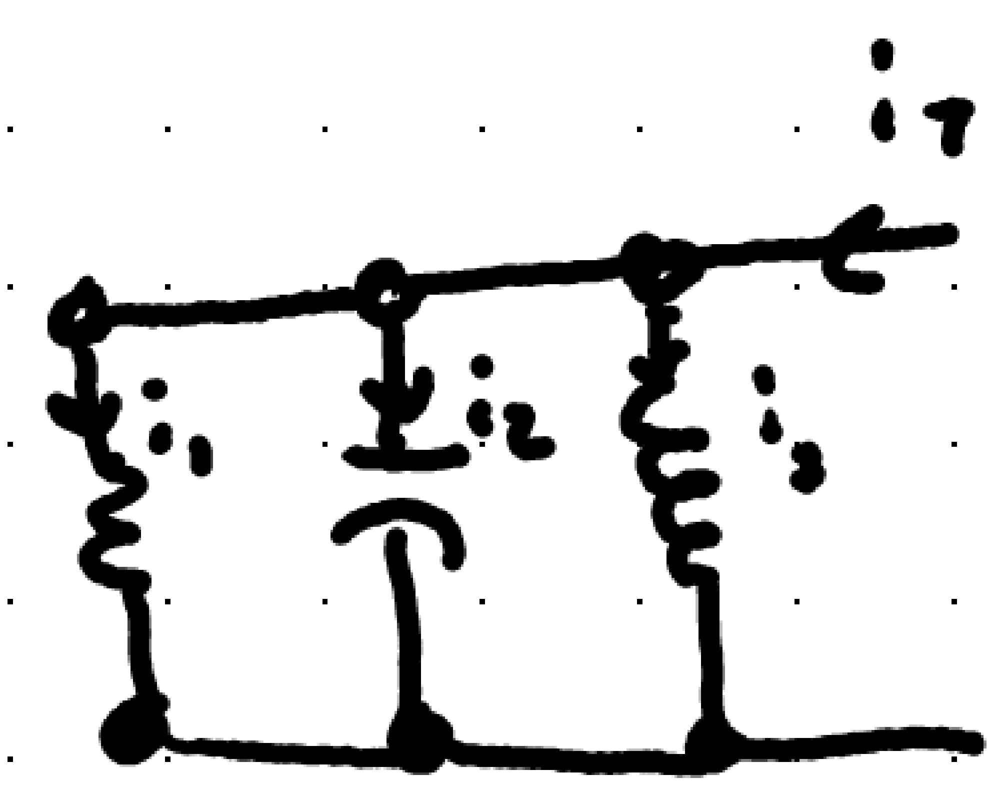


Example

$i_1 = 20\cos(\omega t)$

$i_2 = 10\cos(\omega t + 90°)$

$i_3 = 30\cos(\omega t - 90°)$



Soln

$i_1 = \frac{20}{\sqrt{2}}$

$i_2 = \frac{10}{\sqrt{2}} \angle 90$

$i_3 = \frac{30}{\sqrt{2}} \angle -90$

RMS values

$i_1 + i_2 = 5\sqrt{10} \angle 26.565$

$5\sqrt{10} \angle 26.565 + i_3$

$= 20 \angle -45$

$\downarrow$ Convert back to time

$20\sqrt{2} \angle -45$

$\downarrow$ Convert back to time

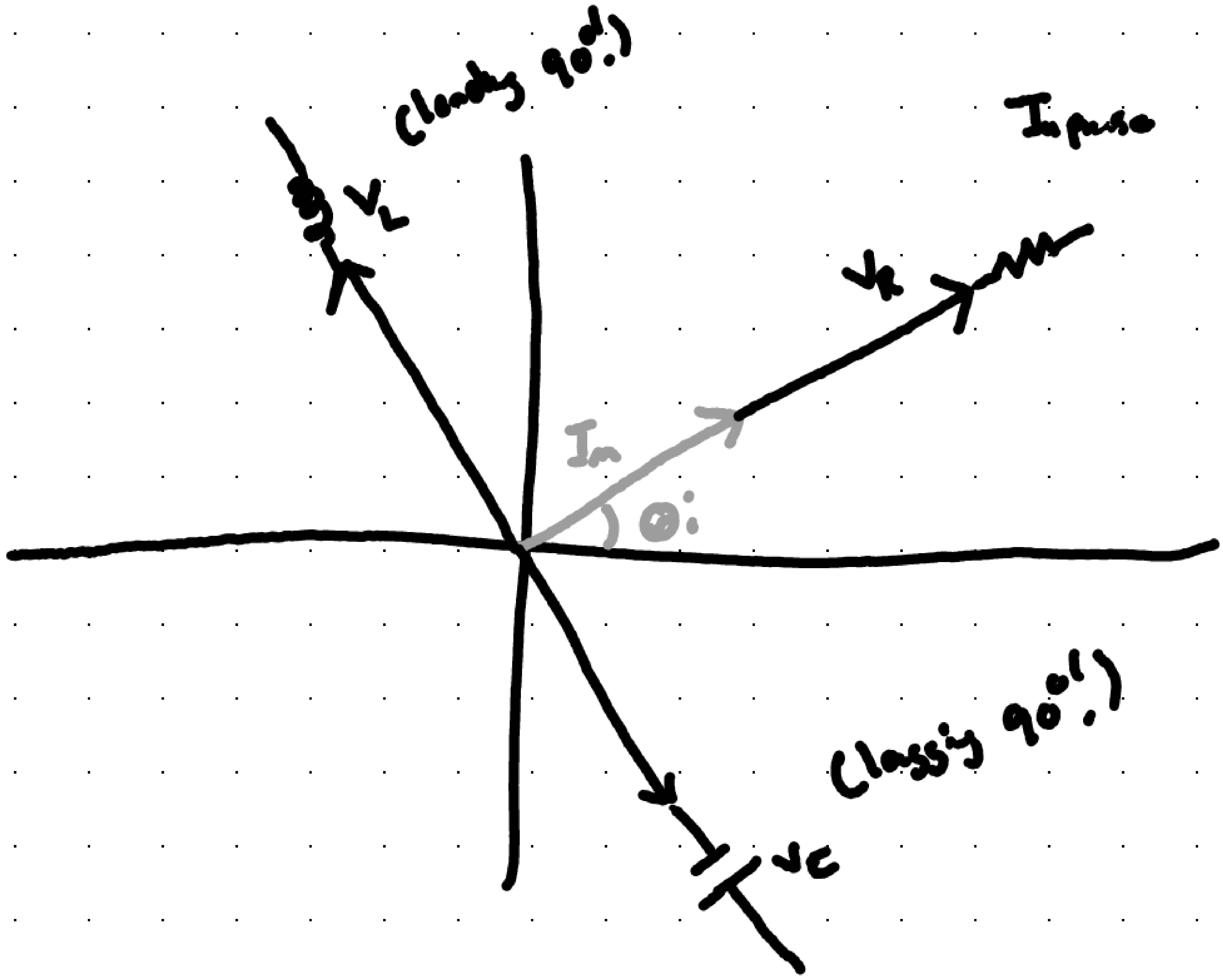
$20\sqrt{2} \cos(\theta - 45)$

Time Domain to phasor domain element Conversion:

	Time	Phasor
Resistor:	$V_R = IR$	$V = IR$
Inductor:	$V_L(t) = L\frac{di}{dt}$	$V_L = \underbrace{(jWL)}_{Z \text{ (impedance)}} \underbrace{I}_{\text{current}}$
Capacitor	$i_c(t) = C\frac{dv_c}{dt}$	$V_c = \left(\frac{1}{jWL}\right) I$

Complex Impedance

$Z_R = R$	$Z_L = jWL$	$Z_c = \frac{1}{jWL}$
Resistance	Reactance	Reactance
(Real)	(Complex)	(Complex)



Voltage (E) Leads I!

Current (I) Leads E

ELI the ICE man!

E – Voltage, L – Inductance, I – Current

I – Current, C – Capacitance, E – Voltage

*Voltage can be written as E sometimes

Now, when $f = 0$ $(\omega = 2\pi f)$, obviously we are working in DC conditions.

- Resistors aren't affected by this, so that's why we use them in DC.

- However, Inductors and Capacitors VERY MUCH are! $V_L = (j\underbrace{\omega}_{2\pi F} L)I$. When $F = 0$, you have no V_L.

- This is why these elements appear as zero in DC!

- On the contrary, as you increase the frequency, the voltage changes proportionally!