Basic Electronics Part 4
Phase and Resonance

- Hamtronics
- Basic Electronics Part 4
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- @Sunlife ARC

Basic Electronics Part 4
Phase and Resonance

Let's have a quick review of C and L and R

ELI the ICE MAN

This means - - -
Voltage leads current in an inductor and …
Current leads Voltage in a capacitor! This is with respect to the resistor value.

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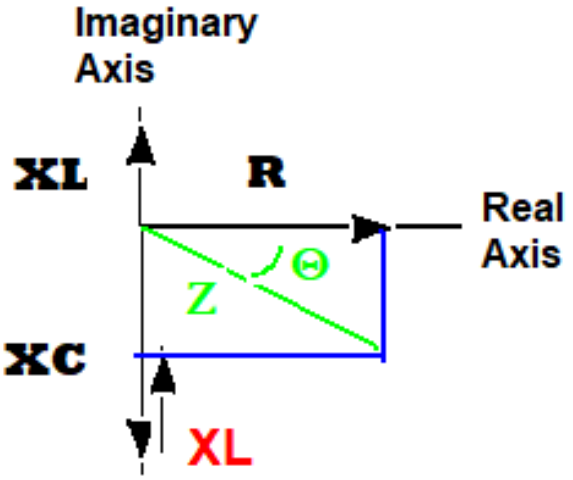
Resonance occurs when the capacitive reactance in the circuit exactly matches the inductive reactance. Or XC=XL

$$XC := \frac{1}{2 \cdot \pi \cdot f \cdot C} \qquad XL := 2 \cdot \pi \cdot f \cdot L$$

$$\frac{1}{2 \cdot \pi \cdot f \cdot C} = 2 \cdot \pi \cdot f \cdot L$$

$$fr := \frac{1}{2 \cdot \pi \cdot \sqrt{L \cdot C}}$$

We represent the XC as lagging (-90 deg) and the XL as Leading (+90 deg)
Since Current leads voltage in XC then Voltage lags current
This is a voltage plot.



This allows us to use math to predict the values of Z and the phase shift that results.

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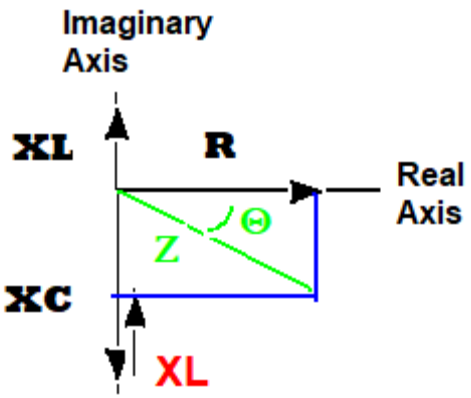
The way to look at it is using *Phasors*

A phasor is a vector showing the relation ship of the value of the reactance and its "phase angle" with respect to each other and any circuit resistance. The phasors are shown with their voltage relationships

Both XC an XL are called the imaginary value of the Impedance, Z

$$Z := R + i \cdot (XC - XL)$$

$$i := \sqrt{-1}$$



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First off, do not let the term “imaginary” throw you off. This is a mathematical way to deal with the shift that these active devices introduce to the AC signal.

There is nothing imaginary about an imaginary number. The problem comes from the existence of the square root of -1 in the definition of the XC and XL values.

Luckily Smath will do all the math for you – If needed.

Smath for non-resonance

$C := 0.5 \cdot 10^{-6}$

$R := 5000$

$L := 3$

$f := 60$

$XC := \frac{1}{2 \cdot \pi \cdot f \cdot C}$

$XC = 5305.1648$

$XL := 2 \cdot \pi \cdot f \cdot L$

$XL = 1130.9734$

$Imaginary := XL + (-XC)$

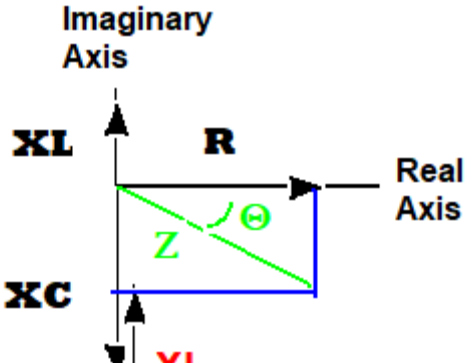
$Imaginary = -4174.1914$

$Z := \sqrt{R^2 + Imaginary^2}$

$Z = 6513.3612$

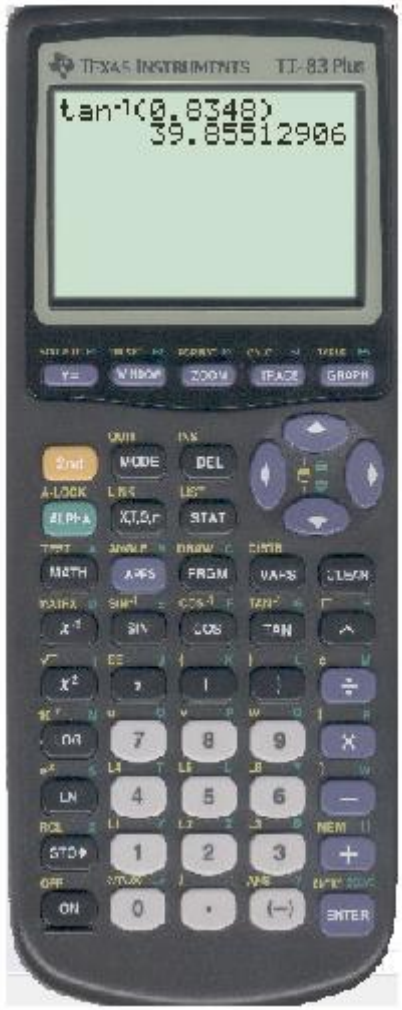
$TANGENT\theta := \frac{Imaginary}{R}$

$TANGENT\theta = -0.8348$



Smath file at
www.drunningham.us/hamtronics

Smath Angle Calculations



Here we use a calculator to find the arctan or tan^-1(0.8348) which gives 39 degrees.

This type of calculation is involved in the Extra Class exam. Those questions are easier to understand with this background.

For a reference see a recent Math section of CQ Magazine.

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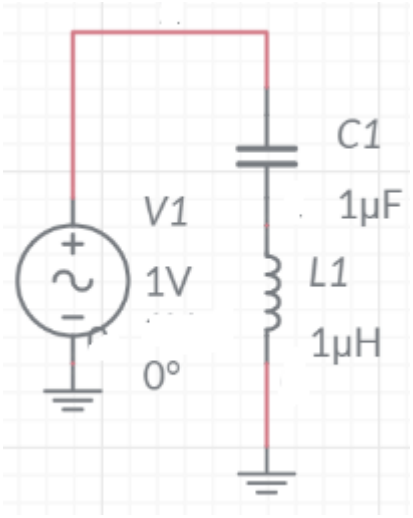
Back to resonance conditions...
At resonance, the pair of C and L have no effective resistance Each cancelling the reactance of the other.



At resonance the fr resonance frequency is

$$L := 1 \cdot 10^{-6}$$
$$C := 1 \cdot 10^{-6}$$

$$L = 1 \cdot 10^{-6} \quad Henries$$
$$C = 1 \cdot 10^{-6} \quad Farad$$

$$fr := \frac{1}{2 \cdot \pi \cdot \sqrt{L \cdot C}}$$

$$fr = 1.5915 \cdot 10^{5} \quad Hertz$$

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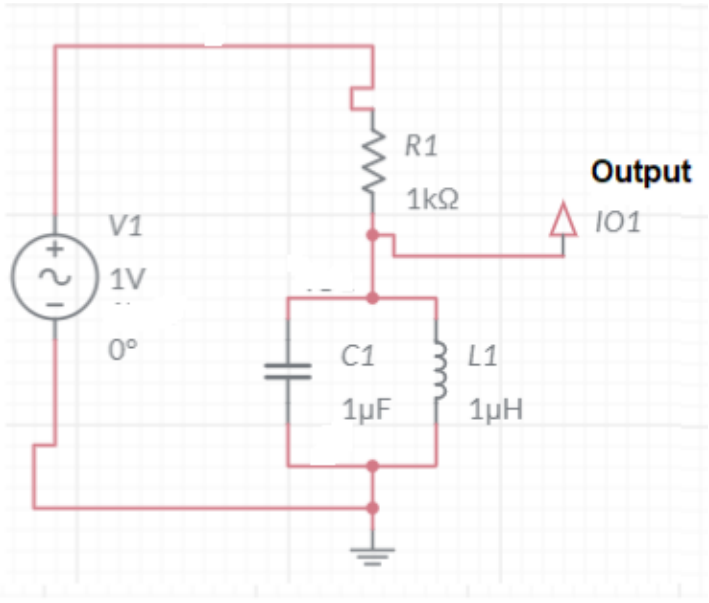


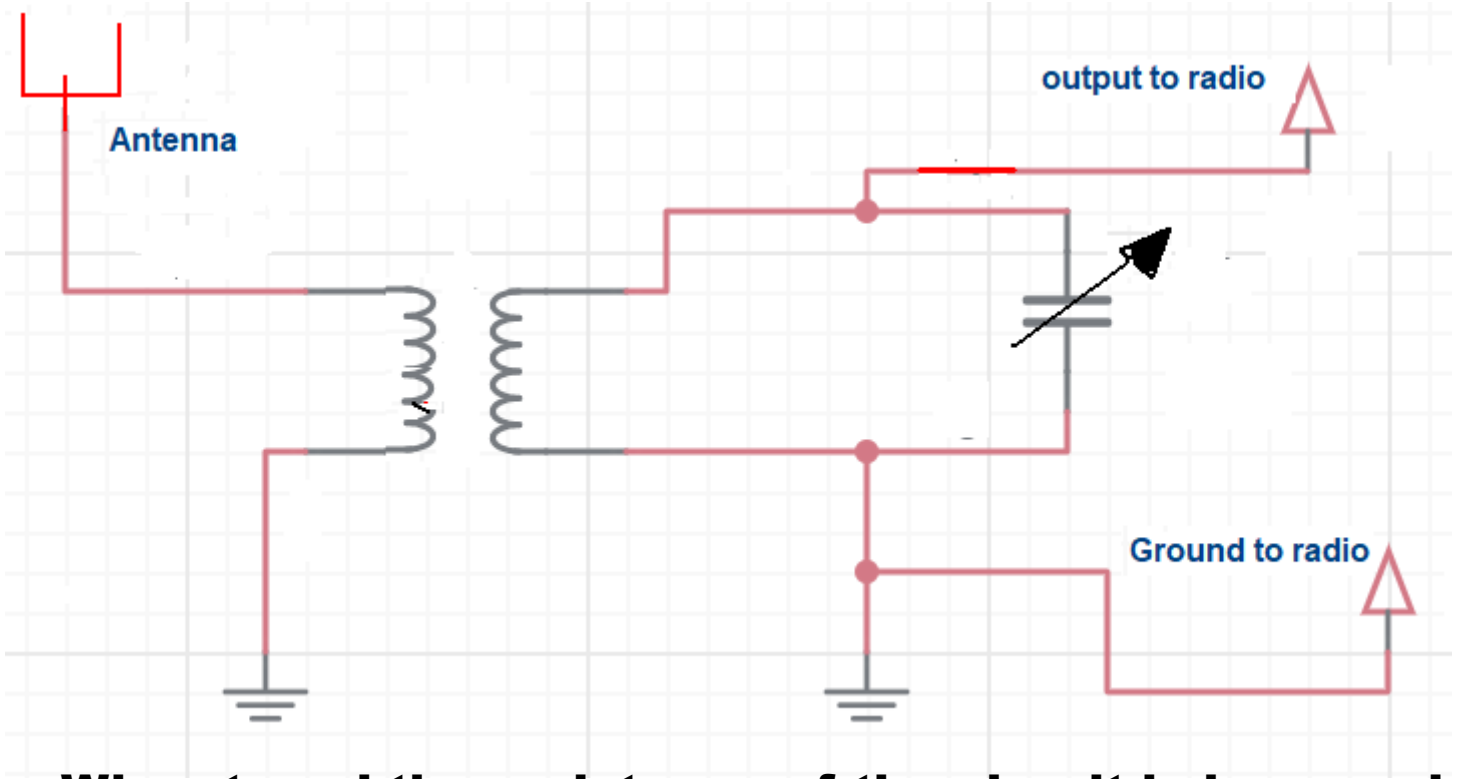
The calculation is the same.

This means
Z= Vsource/Isource
Z=Vsource/0 = Infinite Ohms
Or high impedance!

At resonance the reactance of the combination goes toward infinity… To see this, consider the current in the coil and the capacitor are 180 degrees out of phase. So the net draw from the source is zero. But the voltage is the same. Hence the voltage from the source is seen by the load. In resonance the coil and cap pass the current back and forth to each other.

Tuned Circuit Radio

All sorts of frequencies



When tuned the resistance of the circuit is huge and the voltage is at the resonant freq. This is passed on to the detector stages eventually the amplifier stages.

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In a transmitter the operation can be the same.

More on this topic when we look at receives and transmitters. Coming soon to a Zoom near you.
Now its time for Coffee.

Comments om this or other presentations send to
PLC @ drcunningham.us
Also, topics to consider for future presentations in coming years.

Questions?

www.drcunningham.us/hamtronics