Electrical Engineering Technology

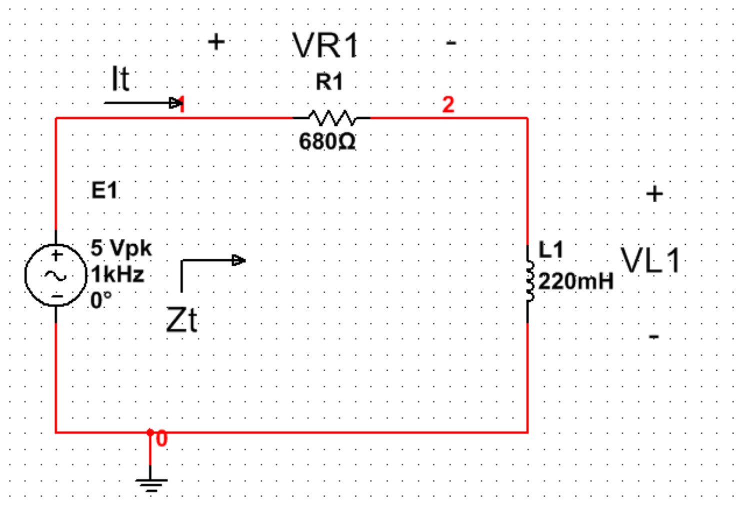
Series AC Circuits (continued)

Spring 2019 (2185)

Series AC Circuits (continued)

- Project #1, Week 1
  - Prelab (partial) discussion – $\mathbf{Z_T}$ for a series R_L Circuit
    - Calculations
    - Simulation (interpretation of results)
- Series RC Circuit – Frequency Response
  - **ICP –In your teams**
    - Check each other's work
    - Help each other with your calculators
  - Simulation Demo (Multisim)
    - Simulation set-up
    - AC magnitude vs Vpeak
    - Compare $\mathbf{Z_T}$ results
    - Compare $\mathbf{V_C}$ results

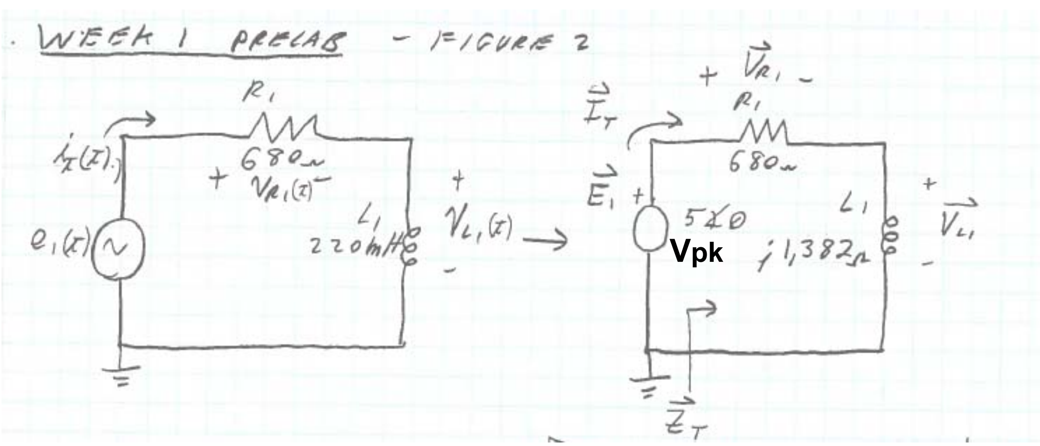
Project #1 – Week 1 Prelab (Partial)



1. Calculate **ZT** and draw the impedance diagram (one RC series circuit, one RL series circuit)
2. Using Multisim, determine **ZT** and draw the impedance diagram
3. *In lab, build the circuit, determine **ZT** and draw the impedance diagram*

1. Calculations – RL Circuit

Convert to the Phasor Domain
(R,L,C -> impedance)



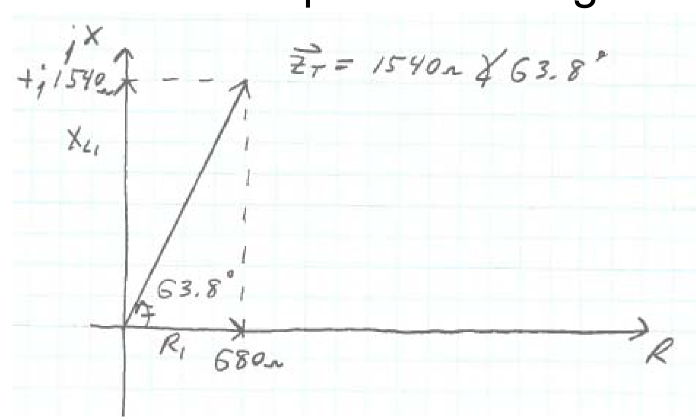
Calculate **ZT**

$$\vec{Z}_T = (680 + j1{,}382)\ \Omega$$

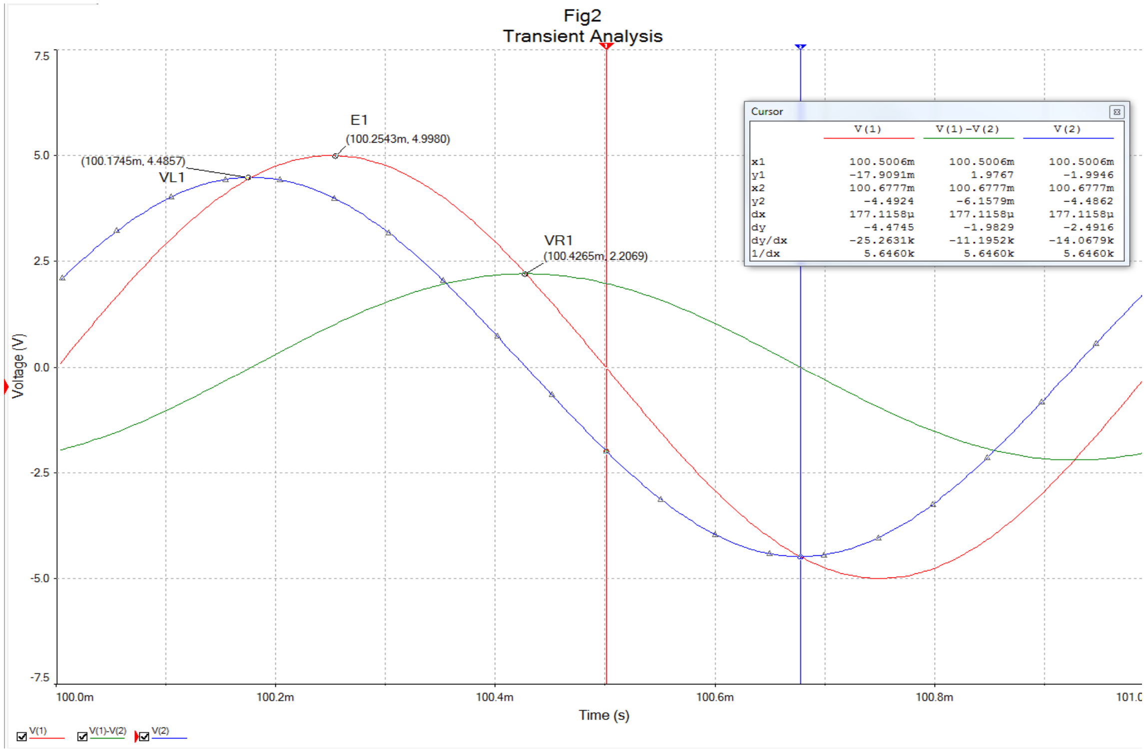
OR

$$1{,}540\ \Omega \angle 63.8^\circ$$

Draw the Impedance Diagram



2. Simulation – RL Circuit



	V(1)	V(1)-V(2)	V(2)
x1	100.5006m	100.5006m	100.5006m
y1	-17.9091m	1.9767	-1.9946
x2	100.6777m	100.6777m	100.6777m
y2	-4.4924	-6.1579m	-4.4862
dx	177.1158µ	177.1158µ	177.1158µ
dy	-4.4745	-1.9829	-2.4916
dy/dx	-25.2631k	-11.1952k	-14.0679k
1/dx	5.6460k	5.6460k	5.6460k

Interpret to Determine **ZT**

$$\vec{Z}_T = \frac{\vec{E}_1}{\vec{I}_T}$$

$$\vec{E}_1 = 5V_{pk} \angle 0°$$

$$|\vec{I}_T| = \left|\frac{\vec{V}_{R_1}}{R_1}\right| = \frac{2.21V_{pk}}{680\Omega}$$

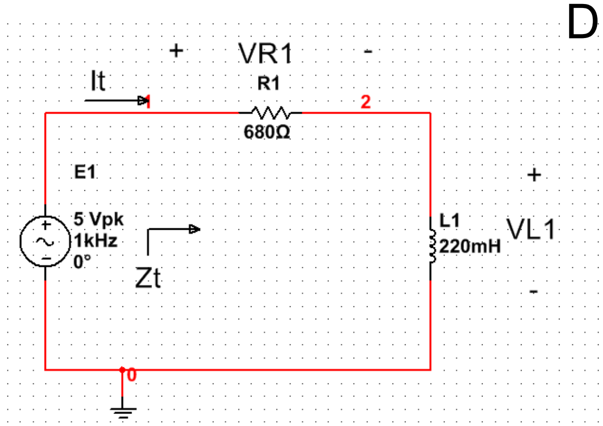
$$= \underline{3.25\,mA_{pk}}$$

$\angle \vec{I}_T \rightarrow \vec{I}_T$ LAGS $\vec{E}_1$ By $177\mu Sec$

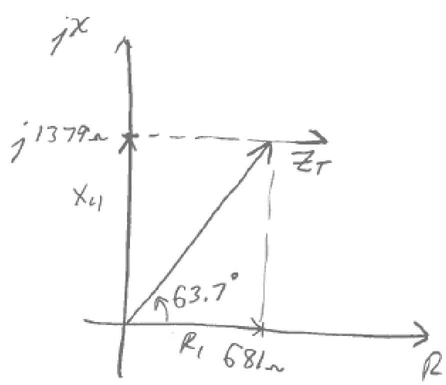
$$\frac{177\mu Sec}{X\ DEG} = \frac{1mSec}{360\ DEG}$$

$$\underline{X = 63.7°}$$

$$\therefore\ \underline{\vec{I}_T = 3.25\,mA_{pk} \angle -63.7°}$$



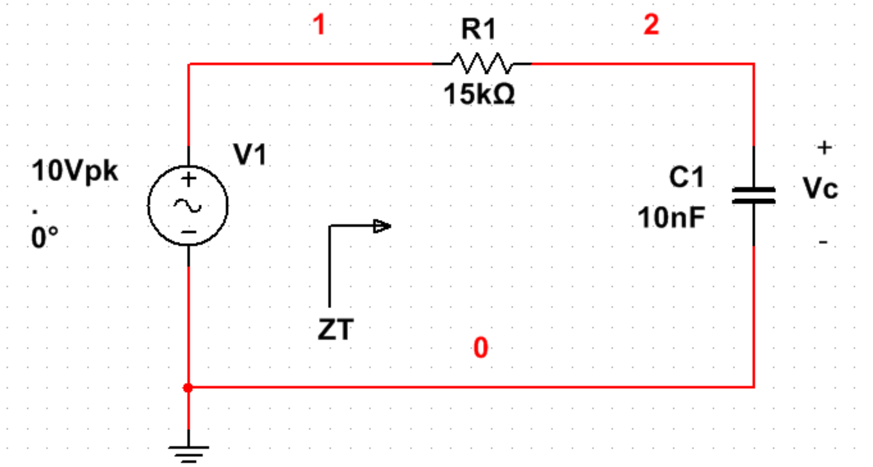
Draw the Impedance Diagram



$$\vec{Z}_T = \frac{5V_{pk}\angle 0°}{3.25mA_{pk}\angle -63.7°}$$

$$\boxed{\vec{Z}_T = 1{,}538\Omega \angle 63.7°}$$

Series R-C Circuit Analysis (ICP)



1. What is the source voltage, **V1** in phasor form?

2. Write an **equation** for the capacitive reactance, X_{C1}

3. Write an **equation** for the total impedance magnitude $|Z_T|$

4. Write an **equation** for the total impedance phase Θ_T

5. Draw the impedance diagram for the circuit at 1 kHz.

6. Write an **equation** for the series current **I**

7. Find the corner frequency, f_1

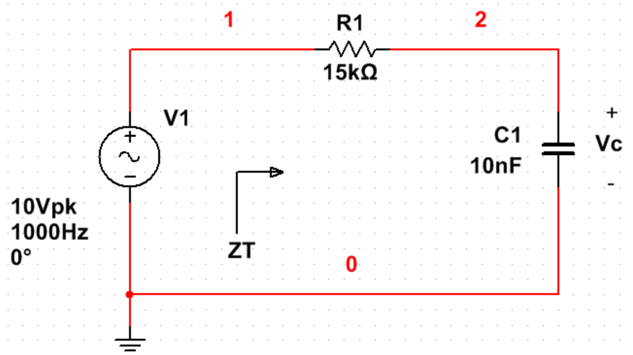
8. Write an **equation** for **Vc**

9. Using your results, check the values in the table below AND complete it:

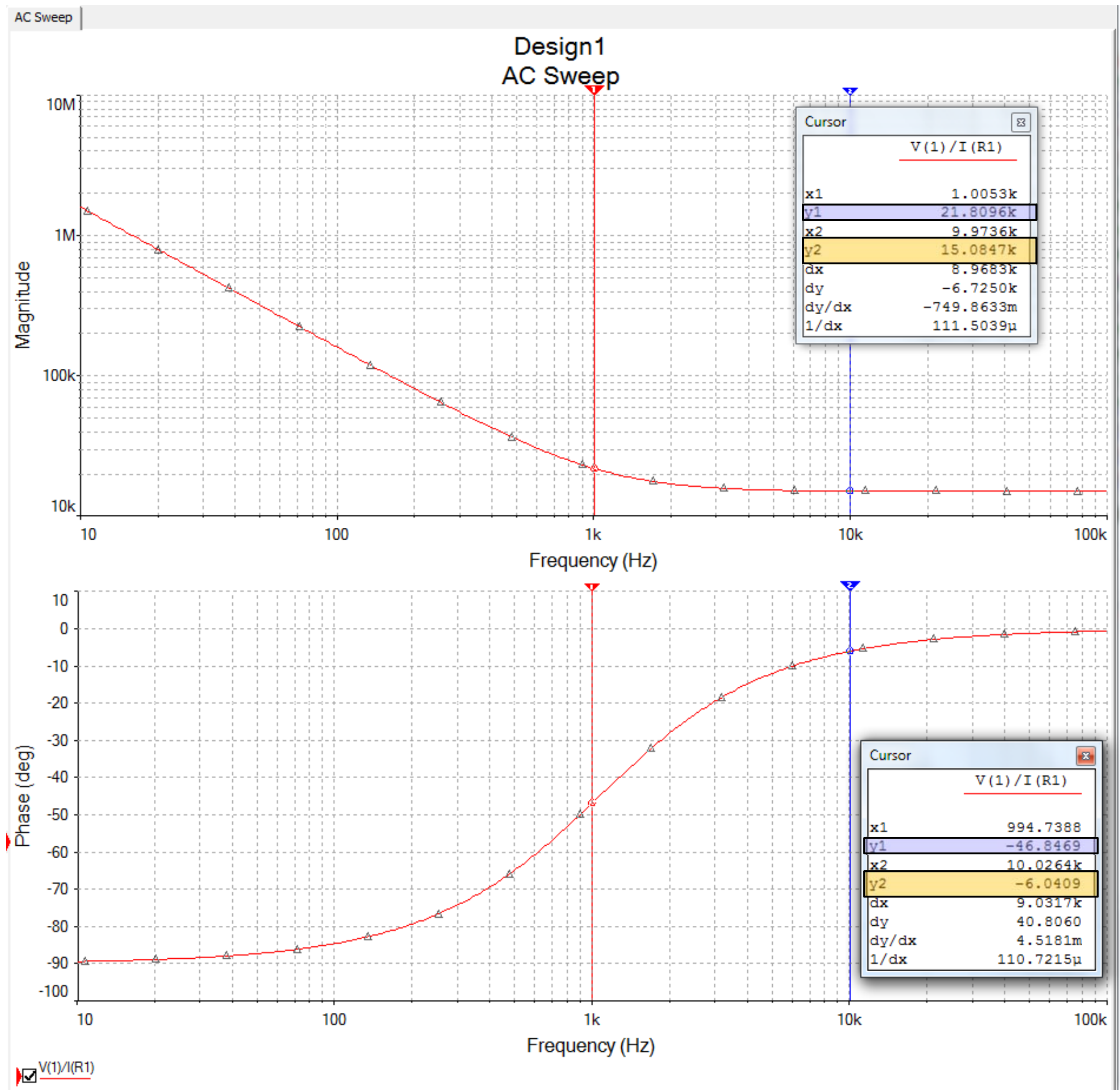
Table 1: Calculated Values for the Series RC Circuit

$f(\text{Hz})$	$X_C(\Omega)$	$Z_T(\Omega)$		$V_C(V\text{pk})$	
		$\lvert Z_T\rvert$	θ_T °	$\lvert V_C\rvert$	θ_C °
10	$1.59 \cdot 10^6$	$1.59 \cdot 10^6$	-89.5	10	-0.54
1000					
10,000					
20,000	795.8	15,021	-3.04	0.53	-87.0

Series R-C Circuit Analysis (Z_T)



f (Hz)	X_C (Ω)	$\vec{Z}_T$
10	1.592×10^6	$1.592\times10^6 \Omega \angle -89.5°$
1,000	15,915	21,870Ω ∠ −46.7°
10,000	1,592	15,084Ω ∠ −6.06°
20,000	795.8	15,021Ω ∠ −3.04°

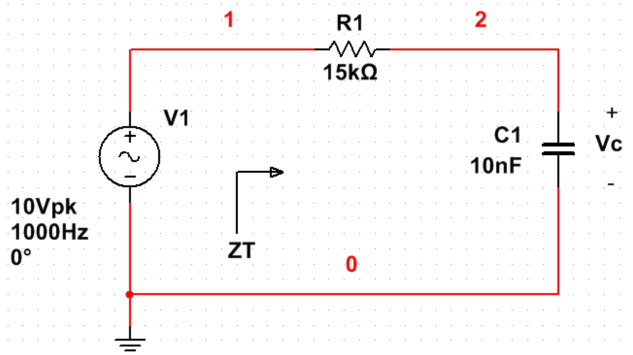


Multisim:

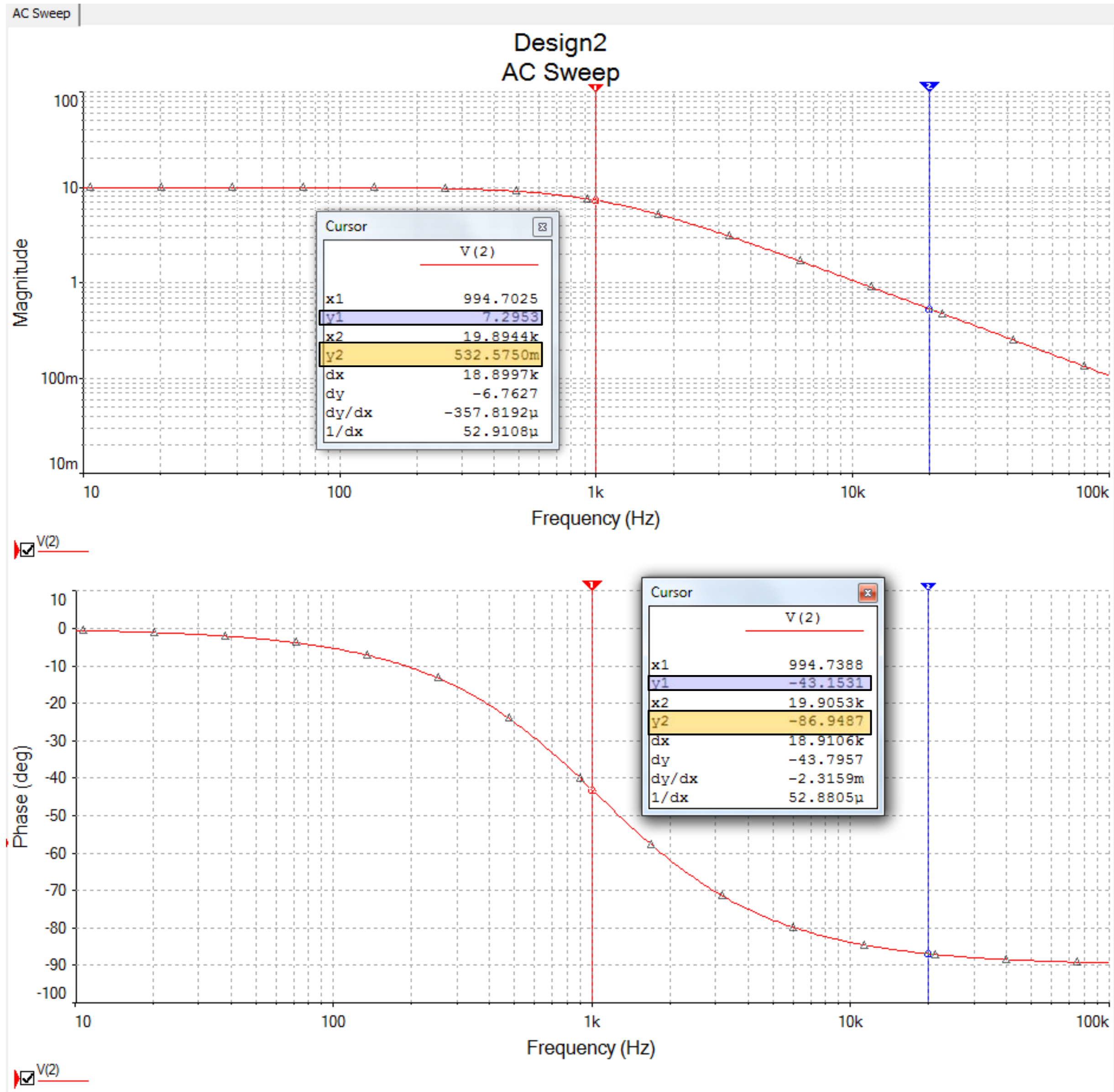
1) Z_T magnitude and angle matches with calculations

- Simulation setup
- Include 100 points/decade or more

Series R-C Circuit Analysis (Vc)



f (Hz)	X_C (Ω)	$\vec{V}_C$
10	1.592×10^6	10.0Vpk ∠-0.54°
1,000	15,915	7.28Vpk ∠-43.3°
10,000	1,592	1.06Vpk ∠-83.9°
20,000	795.8	0.530Vpk ∠-87.0°



Multisim:

1) **Vc** magnitude and angle matches with calculations

- Simulation setup
- Include 100 points/decade or more
- “AC Analysis Magnitude”