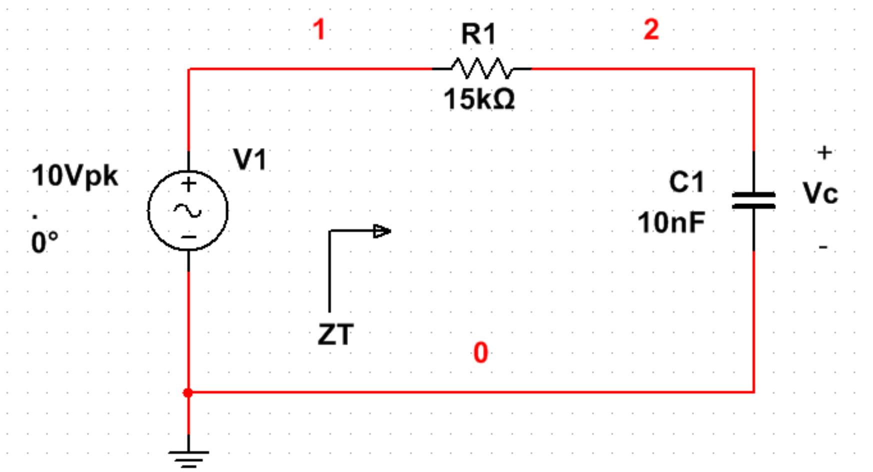
Series R-C Circuit Analysis (ICP)



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(Hz)	$X_C(\Omega)$	$Z_T(\Omega)$		$V_C(V\text{pk})$	
		$\|Z_T\|$	θ_T °	$\|V_C\|$	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

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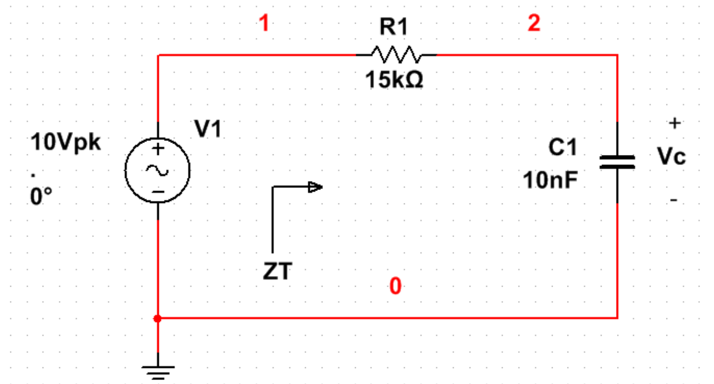


1. What is the source voltage, **V1** in phasor form?

$$\vec{V}_1 = \boxed{10V_{pk}\angle 0^\circ}$$

OR

$$\boxed{7.07V_{RMS}\angle 0^\circ}$$

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

$$\boxed{X_{C_1} = \frac{1}{2\pi f C_1}\ (\Omega)}$$

(EQ1)

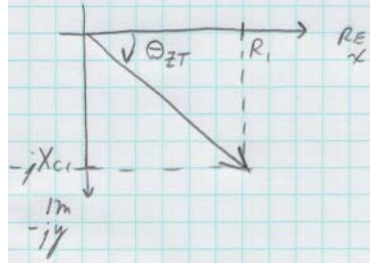
3. Write an **equation** for the total impedance magnitude $|Z_T|$

$$\vec{Z}_T = R_1 - jX_{C1}$$

$$\therefore \boxed{|\vec{Z}_T| = \sqrt{(R_1)^2 + (X_{C1})^2}}$$

(EQ2)

4. Write an **equation** for the total impedance phase Θ_{ZT}



$$\tan(\theta_{Z_T}) = \frac{X_{C1}}{R_1}$$

$$\therefore \boxed{\theta_{Z_T} = -\tan^{-1}\left(\frac{X_{C1}}{R_1}\right)}$$

(EQ3)

θ_{Z_T} IS THE ∡ MADE W/ POSITIVE X-AXIS ∴ θ_{Z_T} IS "−" HERE.

NP

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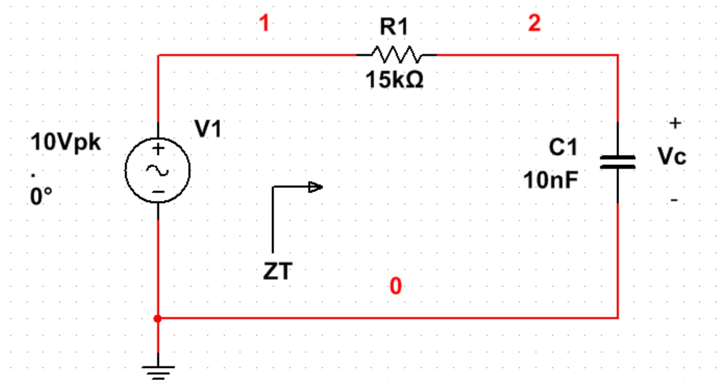


6. Write an **equation** for the series current **I**

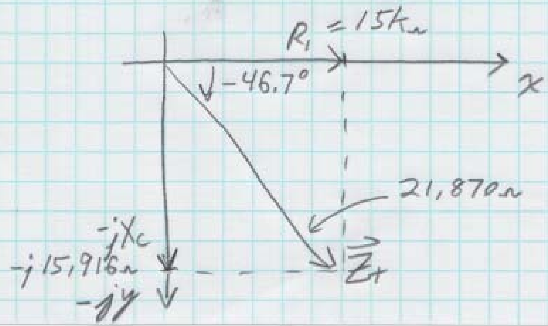
$$\vec{I} = \frac{\vec{V_1}}{\vec{Z_T}} = \boxed{\frac{10V_{pk}\angle 0^\circ}{\vec{Z_T}}}$$

$$\text{OR } \boxed{\frac{10V_{pk}\angle 0^\circ}{\sqrt{R_1^2+X_{C_1}^2}\ \angle -\tan^{-1}\left(\frac{X_{C_1}}{R_1}\right)}}$$

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

$\vec{Z_T}$ @ $f = 1kHz$ $(R_1 = 15k\Omega,\ C_1 = 10nF)$

$= \boxed{21{,}870\Omega \angle -46.7^\circ}$



7. Find the corner frequency, f1

$$f_1 = \frac{1}{2\pi R_1 C_1}$$

$$= \frac{1}{(2)(\pi)(15k\Omega)(10nF)}$$

$$= \boxed{1{,}061\ Hz}$$

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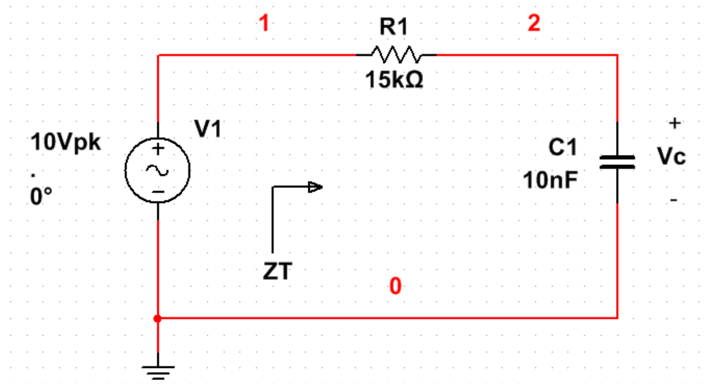

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20,000	795.8	15,021	-3.04	0.53	-87.0

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

$$\vec{V}_c = \vec{I}\cdot\vec{Z}_c = \left(\frac{10V_{pk}\angle 0°}{\vec{Z}_T}\right)\left(\vec{Z}_{c_1}\right)$$
, SAME AS VOLTAGE DIVIDER

SOLVING FOR : X_c, $\vec{Z}_T$ + $\vec{V}_c$ YIELDS:

$$\vec{V}_c = \frac{(10V_{pk}\angle 0°)(X_{c_1}\angle -90°)}{\vec{Z}_T}$$

$$\lvert \vec{V}_c \rvert = \frac{(10V_{pk})(X_{c_1})}{\sqrt{R_1^2 + X_{c_1}^2}}$$ **(EQ4)**

$$\angle \vec{V}_c = -90° - \theta_{Z_T}$$ **(EQ5)**

	EQ1	**EQ2,3**	**EQ4,5**
f (Hz)	X_c (Ω)	$\vec{Z}_T$	$\vec{V}_c$
10	1.592×10^6	$1.592\times10^6\Omega \angle -89.5°$	$10.0V_{pk}\angle -0.54°$
1,000	15,915	$21,870\Omega \angle -46.7°$	$7.28V_{pk}\angle -43.3°$
10,000	1,592	$15,084\Omega \angle -6.06°$	$1.06V_{pk}\angle -83.9°$
20,000	795.8	$15,021\Omega \angle -3.04°$	$0.530V_{pk}\angle -87.0°$

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