1.6 Examples for Sinusoidal Circuits Analysis

Key Words:

Bypass Capacitor

RC Phase Difference

Low-Pass and High-Pass Filter

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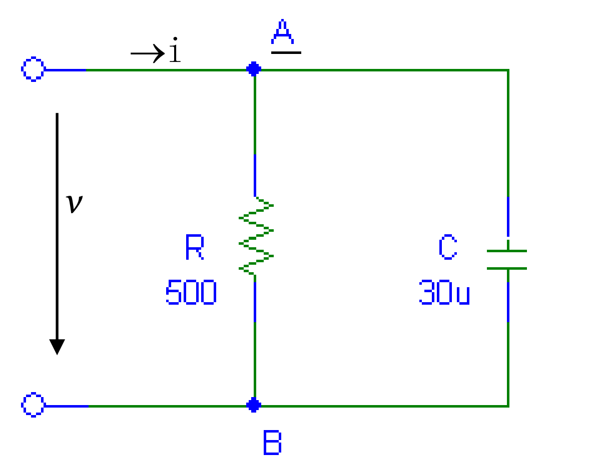
Bypass Capacitor

P4.11, Let $i = 3\times10^{-3}\sqrt{2}\sin\omega t = 3\times10^{-3}\sqrt{2}\sin 2\pi f t = 3\times10^{-3}\sqrt{2}\sin 1000\,\pi t$

f = 500Hz, Determine V_{AB} before the C is connected . And V_{AB} after parallel C = 30μF



Before C is connected

$$V_{AB} = IR = 3\times10^{-3}\times500 = 1.5(V)$$

After C is connected

$$X_C = \frac{1}{2\pi f c} = \frac{1}{1000\times30\times10^{-6}} = 10(\Omega)$$

$$Z = \left(\frac{1}{R} + \frac{1}{-jX_C}\right)^{-1} = 0.2 - 10j = 10\angle -88.85^\circ$$

$$\rightarrow V_{AB} = I|Z| = 3\times10^{-3}\times10 = 30(mV)$$

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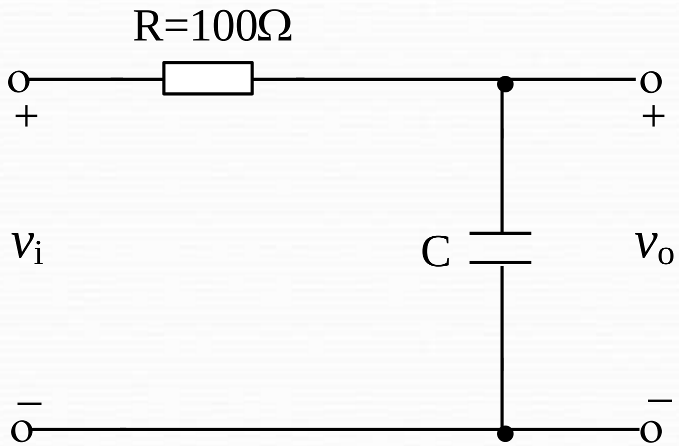
RC Phase Difference

P4.12, $f = 300\text{Hz}$, $R = 100\Omega$。 If $\varphi_{vo} - \varphi_{vi} = \pi/4$， $C = ?$



$$\dot{V}_i = \dot{I}\left(R - jX_C\right) = \left|V_i\right| \angle \varphi_{v_i}$$

$$\dot{V}_o = \dot{I}\left(-jX_C\right) = \left|V_o\right| \angle \varphi_{v_o} = \left|V_o\right| \angle -90^o$$

$$X_C = \frac{1}{\omega C} = \frac{5.31\times 10^{-4}}{C}\Omega$$

$$\frac{\dot{V}_o}{\dot{V}_i} = \frac{-jX_C}{R - jX_C} = \frac{\left|V_o\right|\angle -90^\circ}{\left|V_i\right| \angle arctg \frac{-5.31\times 10^{-6}}{C}}$$

$$\varphi_{v_o} - \varphi_{v_i} = -\frac{\pi}{2} - arctg\frac{-5.31\times 10^{-6}}{C} = \frac{\pi}{4}$$

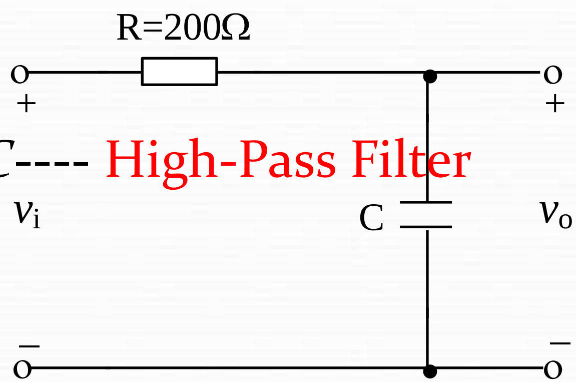
$$arctg\frac{-5.31\times 10^{-6}}{C} = -\frac{\pi}{4}$$

$$\frac{-5.31\times 10^{-6}}{C} = -0.0411$$

$$C = 1.29\times 10^{-4}\,\text{F}$$

4.6 Examples for Sinusoidal Circuits Analysis

Low-Pass and High-Pass Filter



$R \leftrightarrow C$---- High-Pass Filter

$$X_C \propto \frac{1}{f}$$

$$\frac{V_R}{V_C} = \frac{R}{\frac{1}{\omega C}} \longrightarrow V_R X_C = R V_C$$

P4.13, The voltage sources are $v_i = 240 + 100\sin 2\pi 100t$(V), $R = 200\Omega$, $C = 50\mu F$, Determine V_{AC} and V_{DC} in output voltage v_o.

$$V_{DC} = 240V$$

$$X_C = \frac{1}{2\pi fc} = \frac{1}{2\pi \times 100 \times 50 \times 10^{-6}} = 32\Omega$$

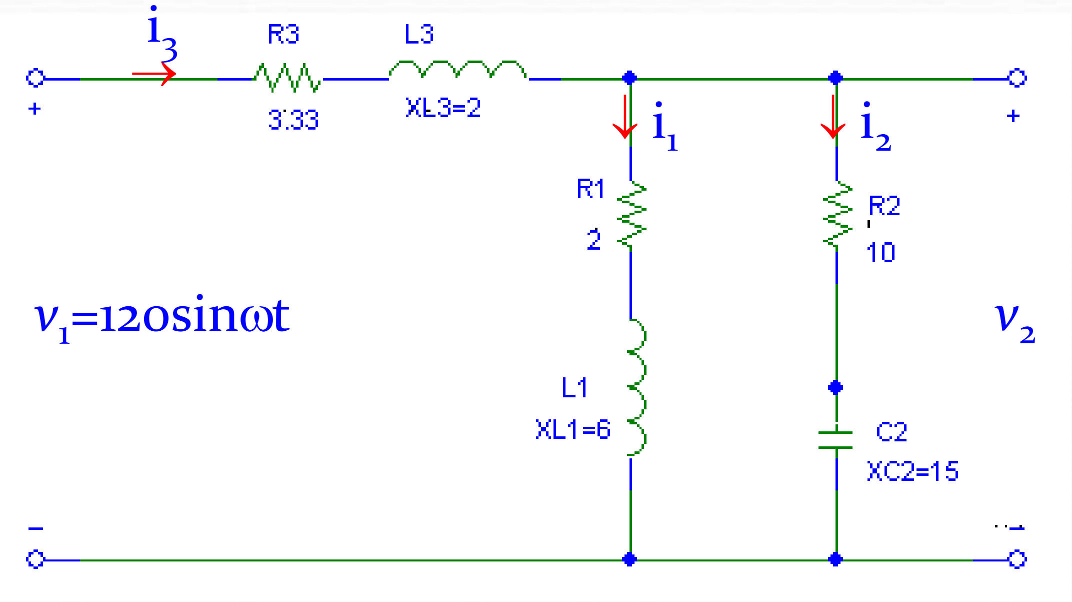
$$V_{AC} = X_C \cdot \frac{V}{Z} = \frac{32}{200} \times 100 = 16(V)$$

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{200^2 + 32^2} \approx 200\Omega$$

1.6 Examples for Sinusoidal Circuits Analysis

Complex Numbers Analysis

P4.14, Find $\dot{I}_1$ $\dot{I}_2$ $\dot{I}_3$ $\dot{V}_2$ in the circuit of the following fig.



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Complex Numbers Analysis

P4.15, Let $V_m = 100$V. Use Thevenin's theorem to find $\dot{I}_{CD}$