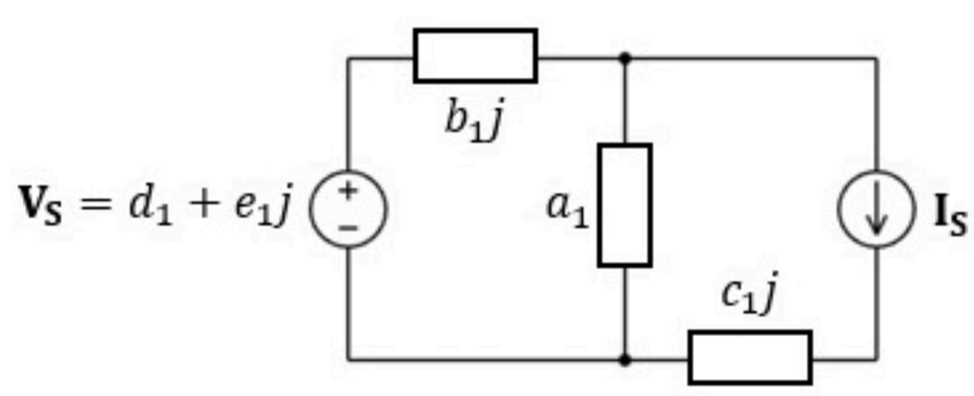
Phasors 017

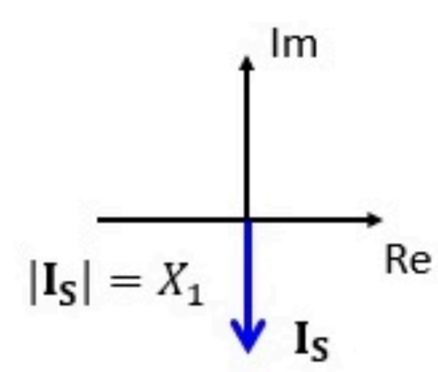
Problem has been graded.

The circuit below represents an AC circuit in steady-state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). Both sources in the circuit have the same ω, but you are not told the value of ω. Each box represents the impedance of a single circuit element (a resistor, capacitor or inductor).

a. What are the maximum values of waveforms $v_S(t)$ and $i_S(t)$? Enter your answers as Y_1 and Y_2, with $Y_1 = \frac{v_{Smax}}{\sqrt{2}}$ and $Y_2 = i_{Smax}$.

b. We now double ω of both sources but keep everything else the same (such as the capacitor, inductor and resistor values; the amplitude and phase of the sources, etc.). Find the new value of all complex numbers in the circuit (the new value of a_1 is called a_2, etc.) as well as the new magnitude of the current source $|\mathbf{I_S}| = X_2$.





Given Variables:

a1 : 30

b1 : -10

c1 : 5

d1 : 6

e1 : 6

X1 : 5 A

Calculate the following:

Y1 (V) :

5.999999999999999

Y2 (A) :

5

a2 :

30

b2 :

-5

c2 :

10

d2 :

6

e2 :

6

X2 (A) :

5

Hint: Which complex numbers are phasors, which are impedances. Omega is implicit for phasors.

The circuit below represents an AC circuit in steady-state in the phasor domain (for the complex numbers, you may assume units are V, A, Ω, etc. as appropriate). Both sources in the circuit have the same ω, but you are not told the value of ω. Each box represents the impedance of a single circuit element (a resistor, capacitor or inductor).

a. What are the maximum value of $v_S(t)$ and $i_S(t)$, called v_{Smax} and i_{Smax} respectively? For v_{Smax}, find Y_1 such that $v_{Smax} = Y_1\sqrt{2}$.

b. We now double ω of both sources but keep everything else the same (such as the capacitor, inductor and resistor values; the amplitude and phase of the sources, etc.). Find the new value of all complex numbers in the circuit (the new value of a_1 is called a_2, etc.) as well as the new magnitude of the current source $|\mathbf{I_S}| = X_2$.

$a_1 = 50$

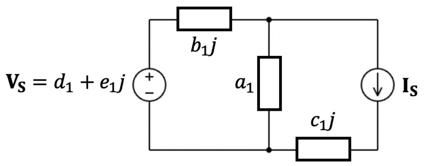
$b_1 = -20$

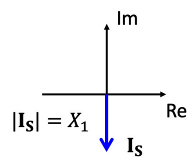
$c_1 = 10$

$d_1 = 1$

$e_1 = 1$

$X_1 = 5A$





a. The max value of a sinusoidal waveform is its amplitude

$$V_{S,max} = |V_S| = \sqrt{d_1^2 + e_1^2} = \sqrt{1^2+1} = \sqrt{2} \Rightarrow Y_1 = 1$$

$$i_{S,max} = |I_S| = X_1 \Rightarrow \boxed{i_{S,max} = 5A}$$

b. Analyze which elements have a dependence on ω

a_1 is the impedance of a resistor $\Rightarrow Z_R = 50$, this has no dependence on ω so if $\omega \to 2\omega$, $50 \to 50 \Rightarrow \boxed{a_2 = 50}$

$b_1 j \Rightarrow -20j$ is the impedance of a capacitor

$$Z_C = \frac{1}{j\omega C} \Rightarrow \text{if } \omega \to 2\omega, \text{ then } \frac{1}{j2\omega C} = \frac{1}{2(j\omega C)} = \frac{1}{2}\cdot\frac{1}{j\omega C} = \frac{1}{2}Z_C$$

$$\text{if } \omega \to 2\omega, \text{ then } -20j \to \frac{1}{2}(-20j) = -10j \Rightarrow \boxed{b_2 = -10}$$

$c_1 j \Rightarrow 10j$ is the impedance of an inductor

$$Z_L = j\omega L \Rightarrow \text{if } \omega \to 2\omega, \text{ then } j2\omega L = 2(j\omega L) = 2Z_L$$

$$\text{if } \omega \to 2\omega, \text{ then } 10j \to 2(10j) = 20j \Rightarrow \boxed{c_2 = 20}$$

$V_s = d_1 + e_1 j = 1 + j$ is the phasor for a source $v_s(t) = \frac{\sqrt{2}}{2}\cos(\omega t + \frac{\pi}{4})$

$$\text{if } \omega \to 2\omega, \text{ then } v_s(t) = \frac{\sqrt{2}}{2}\cos(2\omega t + \frac{\pi}{4}) \Rightarrow V_s = \frac{\sqrt{2}}{2}e^{j\pi/4} = 1 + j \Rightarrow \boxed{\begin{matrix} d_2 = 1 \\ e_2 = 1 \end{matrix}}$$

$\Rightarrow$ the phasor for a voltage waveform does not depend on ω

Similarly, $i_s(t) = 5\cos(\omega t - \frac{\pi}{2})$ if $\omega \to 2\omega$, $i_s(t) = 5\cos(2\omega t - \frac{\pi}{2}) \Rightarrow \boxed{X_2 = 5A}$