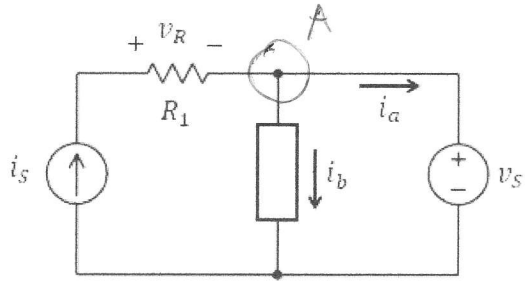
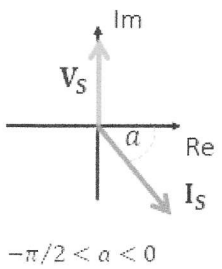
The AC circuit below has $\omega = W_1$ and is in steady state. The phasor diagram shows the phasors of v_S and i_S. You are given the angle a, and vector lengths $|\mathbf{I_S}| = A_1$ and $|\mathbf{V_S}| = A_2\sqrt{b}$. The diagram is not necessarily drawn to scale (but $\mathbf{V_S}$ is along the imaginary axis). The element in the center (rectangular box) is either an inductor or a capacitor but you are not told which.

a. At what time does v_R reach its maximum value? Enter $k = t_0 \cdot \frac{12}{\pi}$, where t_0 is the first time that the maximum is reached, for $t_0 \geq 0$. (Hint: convert a to radians first)

b. We select the mystery element such that $|\mathbf{I_a}|$ is minimized (note that this is the current through the voltage source). What is the mystery element type (enter 1 for capacitor, 2 for inductor)? What is its value X (i.e., either the capacitance or the inductance value, in F or H respectively)?





$W_1 = 2$ rad/s

$a = -30°$

$A_1 = 2A$

$A_2 = 10V$

$b = 3$

$R_1 = 1\Omega$

(a) $V_R = R_1 I_S = R_1 \cdot A_1 e^{ja} = 2e^{-j30°}$

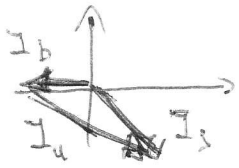
$v_{R\max} = |V_R|$ $\quad v_R(t) = 2\cos(2t - 30°)$ MAX WHEN $\cos(\phi) = 1$

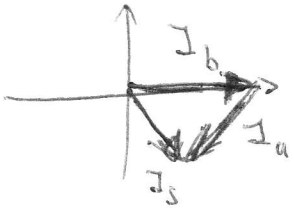
$\phi = 0 \Rightarrow 2t_0 - \frac{\pi}{6} = 0 \Rightarrow t_0 = \frac{\pi}{12} \Rightarrow k = t_0 \cdot \frac{12}{\pi} = 1$ $\boxed{k = 1}$

(b) KCL @ A: $I_S = I_B + I_A$

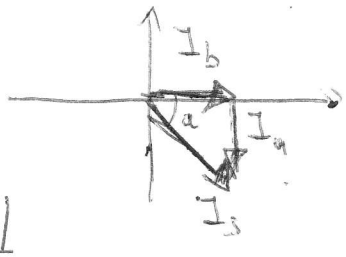
If the mystery element is a capacitor or inductor: I_b is perpendicular to V_S

Let's look at different options





etc. ⇒ smallest I_a



$\cos(-a) = \frac{|I_b|}{|I_S|} \Rightarrow \cos\left(\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2} = \frac{|I_b|}{2}$

$|I_b| = \sqrt{3}$ on the real axis $\Rightarrow I_b = \sqrt{3}$

also: $V_S = Z \cdot I_b \Rightarrow Z = \frac{V_S}{I_b} = \frac{10\sqrt{3}}{\sqrt{3}} j = 10j$

This must be an inductor: $Z = j\omega L = 10j$

$\Rightarrow \omega L = 10 \Rightarrow L = \frac{10}{2} = 5H$

$\boxed{X = 5}$