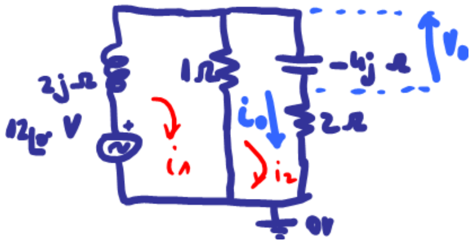
1. (5 points) In the following circuit. (a) Use mesh analysis to find I_0 and V_0 in the network in next figure (ω = 1 rad/s). (b) Find the average power and the power factor in the branch corresponding to I_0. (ω = 1 rad/s), and (c) Find the magnitude and phase of V_0 as a function of ω.



(a) $i_1(1+2j) - i_2 = 12+0j$
$-i_1 + i_2(3-4j) = 0$ $\rightarrow$ $i_2 = \dfrac{\begin{vmatrix}1+2j & 12\\ -1 & 0\end{vmatrix}}{\begin{vmatrix}1+2j & -1\\ -1 & 3-4j\end{vmatrix}} = \dfrac{12}{10+2j}$ A

$i_2 = i_0 = \frac{25}{26} - \frac{5}{26}j$ A = 5*sqrt(1/26) ∠ 2*pi-arctan(1/5) A

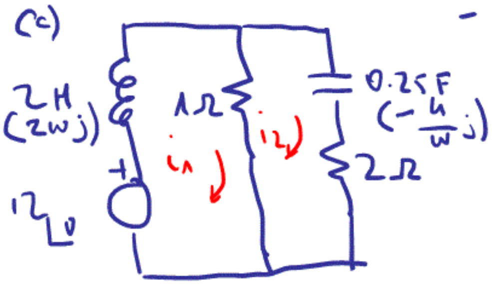
$V_0 = \left(\frac{25}{26} - \frac{5}{26}j\right)(-4j)$ V $= -\frac{10}{13} - \frac{50}{13}j$ = 10*sqrt(2/13) ∠ pi+arctan(5) V

(b) $P_{AV} = \frac{1}{2}|i_0|\cdot|V_1|\cdot$ Power factor $= \frac{1}{2} 5\cdot\sqrt{1/26}\cdot 10\sqrt{2/13}\cos\left(-\arctan(11/3) + \arctan(1/5)\right)$ W

$V_1 = i_0\cdot(2-4j) = \frac{15}{13} - \frac{55}{13}j$ = (5*sqrt(10/13) ∠ 2*pi--arctan(11/3) V

Power factor $= \cos(\theta_{V_1} - \theta_{i_0}) = \cos\left(-\arctan(11/3) + \arctan(1/5)\right)$

(c)



$-4j = -\frac{1}{C\omega}j$, $2j = L\omega j$ $(\omega = 1)$ $\rightarrow$ $C = 0.25$ F, $L = 2$ H

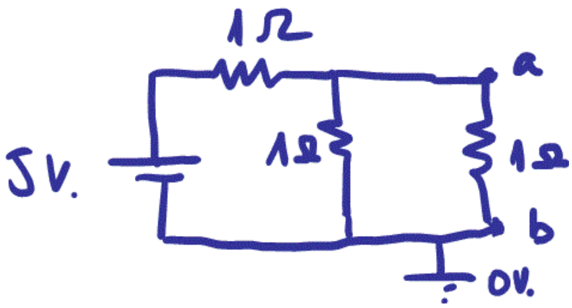
$i_1(1+2\omega j) - i_2 = 12$
$-i_1 + i_2\left(3 - \frac{4}{\omega}j\right) = 0$ $\Big\}$ $i_2 = \dfrac{\begin{vmatrix}1+2\omega j & 12\\ -1 & 0\end{vmatrix}}{\begin{vmatrix}1+2\omega j & -1\\ -1 & 3-\frac{4}{\omega}j\end{vmatrix}} = \dfrac{12}{10+\left(6\omega - \frac{4}{\omega}\right)j}$ A

$i_2 = i_0$

$V_0(\omega) = \left(-\frac{4}{\omega}j\right)\left(\dfrac{12}{10+\left(6\omega-\frac{4}{\omega}\right)j}\right) = \dfrac{-48j}{10\omega + (6\omega^2-4)j} = \dfrac{48}{4-6\omega^2+10\omega j}$

$V_0 = \dfrac{\sqrt{48}}{\sqrt{(4-6\omega^2)^2 + 100\omega^2}} \angle -\arctan\dfrac{10\omega}{4-6\omega^2}$

2. (5 points) Given the following circuit. Find (across nodes a and b): (a) the Thevenin equivalent, (b) the Norton equivalent.



(a) R_{TH}

$\frac{1}{R_{TH}} = \frac{1}{1\Omega} + \frac{1}{1\Omega} + \frac{1}{1\Omega}$

$R_{TH} = \frac{1}{3}\Omega$

V_{TH}

$V_{TH} = V_{ab}$

$V_{ab} = 5V \cdot \frac{1/2\,\Omega}{3/2\,\Omega} = \frac{5}{3}V = V_{TH}$

Thevenin equivalent:

(b) $R_{TH} = R_N = \frac{1}{3}\Omega$

$\frac{3}{2}\Omega \cdot i_A - \frac{1}{2}\Omega \cdot I_N = 5V.$

$(I_N - i_A) \cdot \frac{1}{2} = 0 \rightarrow I_N = i_A$

$\frac{3}{2}\Omega \cdot I_N - \frac{1}{2}\Omega \cdot I_N = 5V \rightarrow I_N = 5A$

Norton equivalent: