Exercises 10
-
Phasors

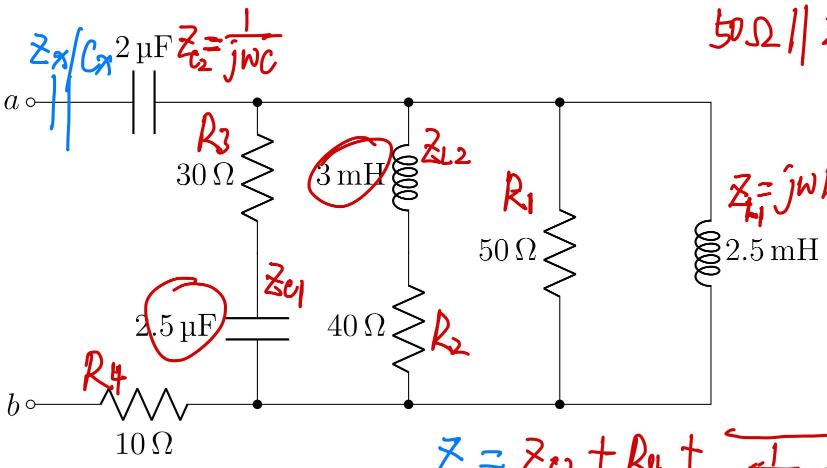
Exercise 1 - Equivalent impedance/admittance 1

$\frac{1}{j\omega C_x} = 40j\,\Omega$

$C_x = -2.5\,\mu F$

$C_x + 2\mu F = \frac{-2.5\mu F \times 2\mu F}{-2.5\mu F + 2\mu F} = \frac{5}{0.5}\mu F = 10\,\mu F$

$50\Omega \parallel 2.5mH = \frac{R_1 \cdot Z_{L1}}{R_1 + Z_{L1}}$

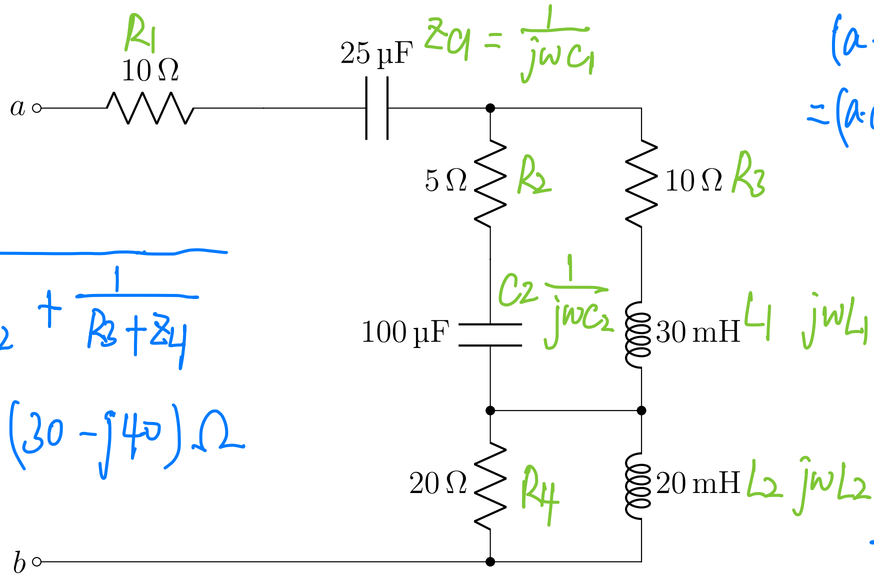


$Z = Z_{C2} + R_4 + \frac{1}{\frac{1}{Z_4} + \frac{1}{R_1} + \frac{1}{Z_{L2}+R_2} + \frac{1}{R_3+Z_{C1}}} = (\frac{70}{3} - 40j)\Omega$

Z Y

- Determine the equivalent impedance/admittance for an angular frequency $\omega = 10\,000\,\text{rad/s}$.
- If we want the current and voltage for that equivalent impedance to be in phase for that frequency, by which value of capacitance should we change the $2\,\mu F$ capacitor?

Exercise 2 - Equivalent impedance/admittance 2 ①



$(a+jb)\cdot(c+jd) = (a\cdot c - b\cdot d) + j(a\cdot d + b\cdot c)$

$Z_{eq} = R_1 + Z_{C1} + \frac{1}{\frac{1}{R_2+Z_{C2}} + \frac{1}{R_3+Z_{L1}}} + \frac{1}{\frac{1}{R_4} + \frac{1}{Z_{L2}}} = (30 - j40)\,\Omega$

$\frac{a+jb}{c+jd} = \frac{(a+jb)\cdot(c-jd)}{(c+jd)\cdot(c-jd)} = \frac{(ac+bd)+j(bc-ad)}{c^2+d^2}$

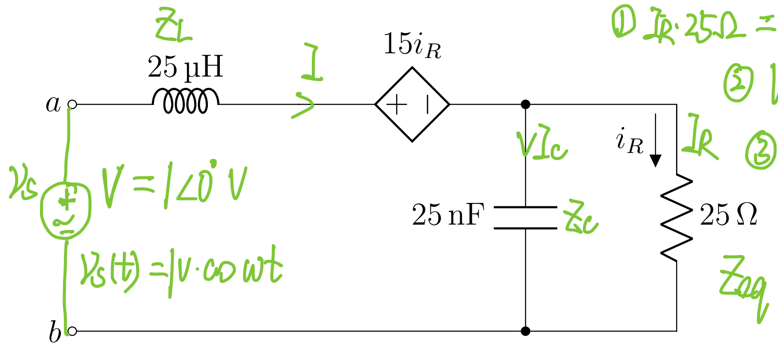
- Determine the equivalent impedance/admittance for an angular frequency $\omega = 1000\,\text{rad/s}$.

Exercise 3 - Equivalent impedance/admittance 2

① $I_R \cdot 25\Omega = I_C \cdot Z_C$

② $V = I \cdot Z_L + 15 I_R + I_C \cdot Z_C$

③ $I = I_C + I_R$



$Z_{eq} = \frac{V}{I} \approx 20 \cdot (1+j)\,\Omega$

- Determine the equivalent impedance/admittance for an angular frequency $\omega = 1.6$ Mrad/s.

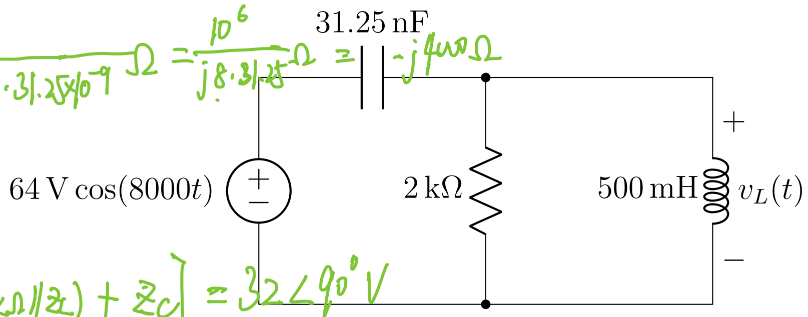
Exercise 4 - Circuit 1

① $\omega = 8000$ rad/s

② $Z_C = \frac{1}{j\omega C} = \frac{1}{j \cdot 8000 \cdot 31.25 \times 10^{-9}}\,\Omega = \frac{10^6}{j\,8 \cdot 31.25}\,\Omega = -j4000\,\Omega$

$Z_L = j\omega L = 4000j\,\Omega$

③ $V = 64\angle 0^\circ$ V



$V_L = V \cdot (2k\Omega \,//\, Z_L) \Big/ \left[(2k\Omega \,//\, Z_L) + Z_C\right] = 32\angle 90^\circ$ V

- Determine the steady-state expression for $v_L(t)$.

$v_L(t) = 32\,V \cos(8000t + 90^\circ)$
$= -32V \sin(8000t)$

Exercise 5 - Circuit 2

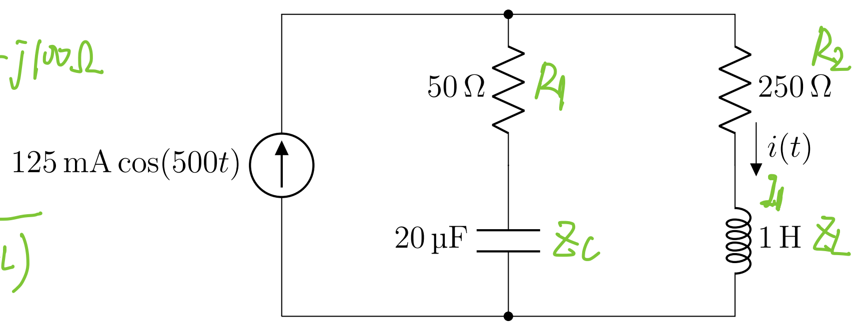
① $\omega = 500$ rad/s

② $Z_L = j500\,\Omega$ $\quad Z_C = -j100\,\Omega$

③ $I = 0.125\angle 0^\circ$ A

④ $I_1 = I \cdot \frac{R_1 + Z_C}{(R_1 + Z_C) + (R_2 + Z_L)}$

$= 28\angle -116.6^\circ$ mA



- Determine the steady-state expression for $i(t)$.

⑤ $i(t) = 28\text{mA} \cos(500t - 116.6^\circ)$

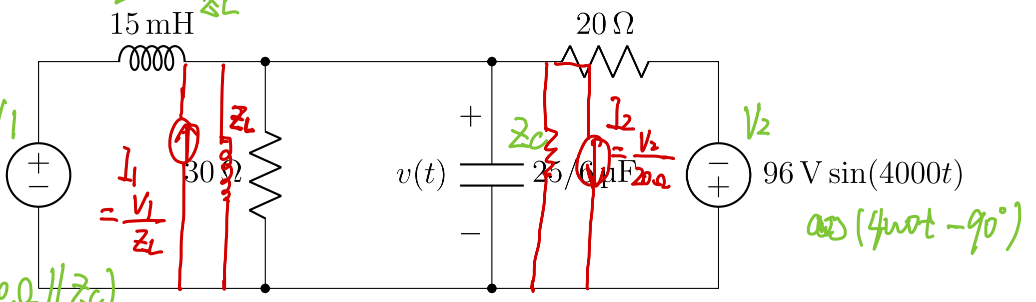
Exercise 6 - Source transformation

① $\omega = 4000$ rad/s

② Z_L, Z_C

③ $V_1 = 240\angle 53.13° \text{ V}$

$V_2 = 96\angle -90° \text{ V}$



④ $V = (I_1 - I_2)\cdot(Z_L \,//\, 30\Omega \,//\, 20\Omega \,//\, Z_C)$

- Using source transformation, determine the steady-state expression for $v(t)$.

⑤ $v(t) =$

Exercise 7 - Superposition

① $\omega_1 = 2000$ rad/s

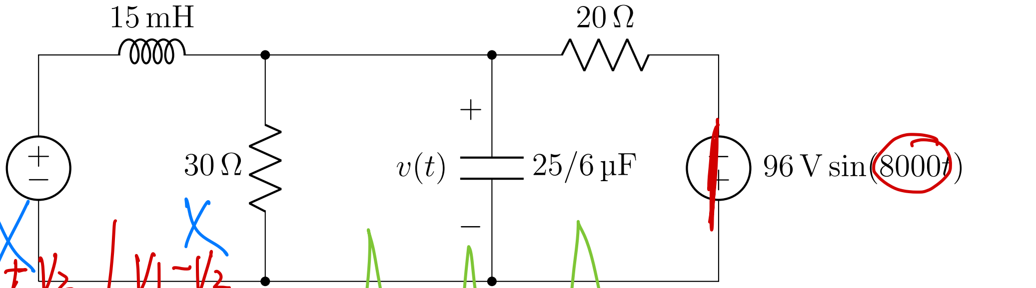
Z_L, Z_C

$V_1 = A_1\angle\phi_1$

② $\omega_2 = 8000$ rad/s

Z_L, Z_C

$V_2 = A_2\angle\phi_2$



$V = V_1 + V_2$ | $V_1 - V_2$

- Using superposition, determine the steady-state expression for $v(t)$.

③ $v(t) = A_1\cdot\cos(2000t + \phi_1) + A_2\cdot\cos(8000t + \phi_2)$

Exercise 8 - Circuit 3

① $I_a = \dfrac{I_b\cdot(15\Omega - j15\Omega)}{(25\Omega + j25\Omega)} = A_1\angle\phi_1 \text{ A}$

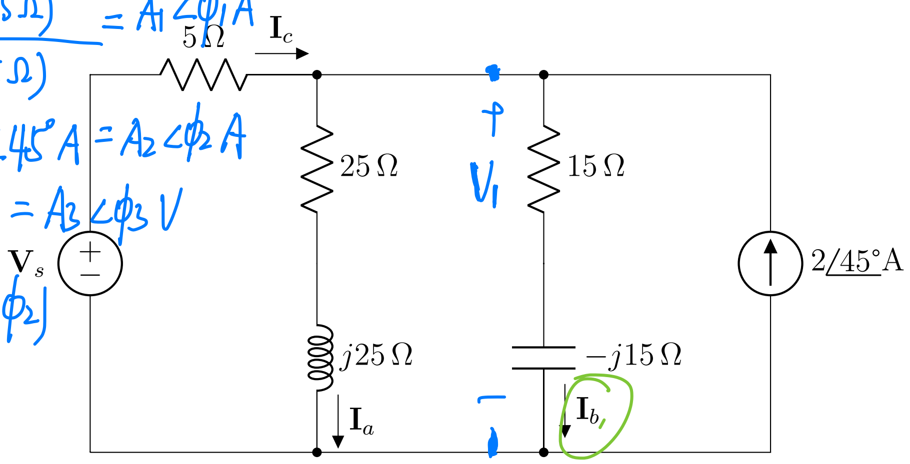
② $I_c = I_a + I_b - 2\angle 45° \text{ A} = A_2\angle\phi_2 \text{ A}$

③ $V_s = 5\Omega\cdot I_c + V_1 = A_3\angle\phi_3 \text{ V}$

④ $i_a = A_1 \cos(800t + \phi_2)$

i_c

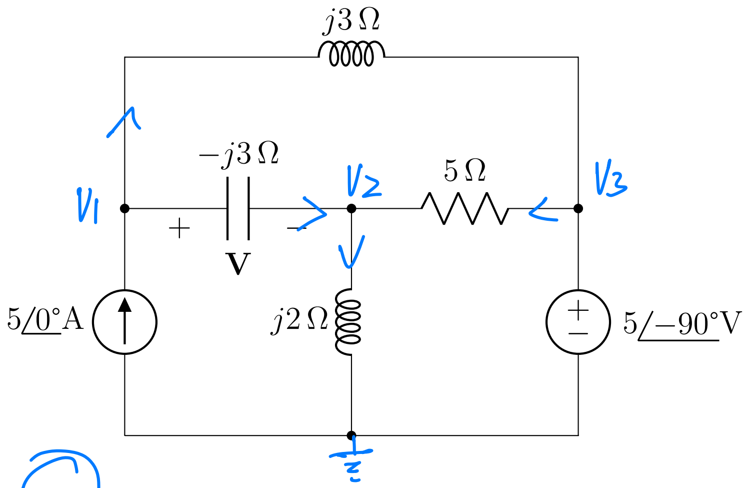
v_s



Knowing that $\mathbf{I}_b = 5\angle 45°$A:

- Determine $\mathbf{I}_a$, $\mathbf{I}_c$ and $\mathbf{V}_s$
- For $\omega = 800$ rad/s, give the expression for $i_a(t)$, $i_c(t)$ and $v_s(t)$.

Exercise 9 - Circuit 4



- Determine the phasor **V**.

$$\begin{cases} V_3 = 5\angle -90^\circ\ V \\ \dfrac{V_3 - V_2}{5\Omega} + \dfrac{V_1 - V_2}{-j3\Omega} = \dfrac{V_2}{j2\Omega} \\ \dfrac{V_1 - V_2}{-j3\Omega} + \dfrac{V_1 - V_3}{j3\Omega} = 5\angle 0^\circ A \end{cases} \Rightarrow \begin{cases} V_1 = \\ V_2 = \\ V_3 = \end{cases}$$

$$V = V_1 - V_2$$