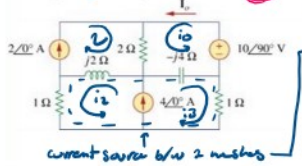
AC Circuits

April 20, 2020 7:23 PM

AC Circuit Analysis

Mesh Analysis

ex. Find I_o



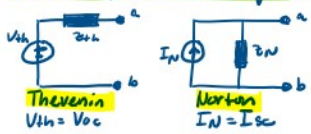
KVL: ① $10\angle 90° = 2(2+i_o)$

② $I_2 + I_3 = 4\angle 0°$

mesh meth → ③ $-j4(I_o+I_3) + 1I_3 + 1I_2 + j2(I_2+2) = 0$

→ solve: $I_o = 3.35\angle 174.3° A$

Thevenin & Norton Analysis



Thevenin: $V_{th} = V_{oc}$

Norton: $I_N = I_{sc}$

Superposition

- Multiple frequencies involved: solve phasor circuit independently
- Sum of time-domain responses
- Short V sources, Open current sources

Thevenin w/ dependent Sources (1A/2A Test+)

- Finding Thevenin w/ dependent current sources
- Solve KCL w/ 1A source @ terminals for V_a
- Solve KCL w/ 2A source @ terminals for V_b
- Keep dependent & independent sources

★ Webwork ST1

ST1: Problem 2

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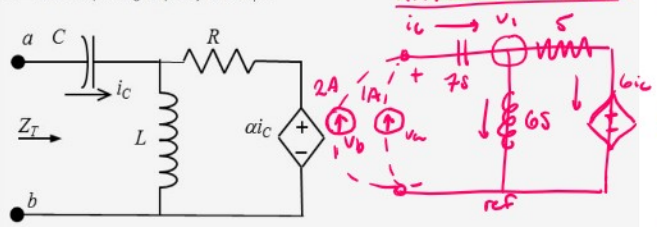
(12 points)

Let $R = 5\Omega$, $C = \frac{1}{7}F$, $L = 6H$ and $\alpha = 6V/A$. Determine the requested quantities seen at terminals $a - b$ for an operating frequency of $4rad/s$:



1A/2A Test source

Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. Impedance: $Z_T =$ [ ] ∠ [ ] °Ω

b. Series-Resistance: $R_T =$ [ ] Ω

c. Series-Reactance: $X_T =$ [ ] Ω

d. Parallel-Conductance: $G_T =$ [ ] S

e. Parallel-Susceptance: $B_T =$ [ ] S

1A Source

KCL: $1 = \frac{V_1}{6S} + \frac{V_1 - 6(1)}{5}$

$V_a = V_1 + (1)7S$

→ solve: $V_a = 10.5424 + 0.4463j$

2A Source

KCL: $2 = \frac{V_2}{6S} + \frac{V_1 - 6(2)}{5}$

$V_b = V_1 + 2 \cdot 7S$

→ solve: $V_b = 41.084858 + 0.892678j$

$\begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix}\begin{bmatrix} V_{th} \\ R_{th} \end{bmatrix} = \begin{bmatrix} V_a \\ V_b \end{bmatrix} \rightarrow \begin{cases} V_{th} + R_{th} = V_a \\ 2V_{th} + R_{th} = V_b \end{cases}$

→ Solve: $R_{th} = 10.542458 + 0.446634j$

Sets
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User Settings
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ST1: Problem 6

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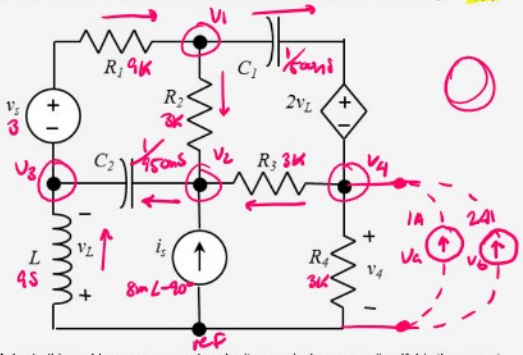
(13 points)
In the circuit shown, $R_1 = 9k\Omega$, $R_2 = 3k\Omega$, $R_3 = 7k\Omega$, $R_4 = 3k\Omega$, $C_1 = 500nF$, $C_2 = 950nF$ and $L = 9H$. Given that $v_s(t) = 3\cos(500t)\ V$ and $i_s(t) = 8\sin(500t)\ mA$, determine the Thevenin equivalent *seen* by resistor R_4 (assume the lower node as the reference) and use this to determine the signal $v_4(t)$.



Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $Z_{Th} =$ ____ $\angle$ ____ $^\circ k\Omega$

b. $V_{Th} =$ ____ $\angle$ ____ $^\circ V$

c. $v_4(t) =$ ____ $cos(500t+$ ____ $^\circ)V$

1A source

CT: $v_1 = -v_3$

KCL1: $\frac{v_3+3-v_1}{9k} = \frac{v_1-v_2}{3k} + \frac{v_1-2v_2-v_4}{1/500ns}$

KCL2: $8mL-90 + \frac{v_1-v_2}{3K} + 1 = \frac{v_2-v_3}{1/450ns}$ → $s = 500j$

KCL3: $\frac{v_2-v_3}{1/450ns} + \frac{-v_3}{9s} = \frac{v_3+3-v_1}{9k}$

KCL4: $\frac{v_3+3-v_4}{9k} = \frac{v_1-v_2}{3k} + \frac{v_1-2v_2-v_4}{1/500ns}$

→ solve (1A): $V_{4a} = -4167.751702 - 3081.100298j$
→ solve (2A): $V_{4b} = -8311.809629 - 6094.17011j$

$\begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} V_{th} \\ R_{th} \end{bmatrix} = \begin{bmatrix} V_{4a} \\ V_{4b} \end{bmatrix}$ → $V_{th} = \ldots$ $R_{th} = \ldots$

Courses
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ST1: Problem 7

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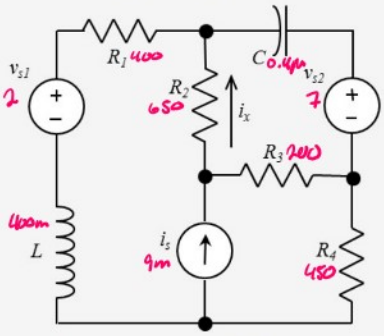
(13 points)
In the circuit shown, $R_1 = 400\Omega$, $R_2 = 650\Omega$, $R_3 = 200\Omega$, $R_4 = 450\Omega$, $C = 0.4\mu F$ and $L = 400mH$. Given that $v_{s1}(t) = 2\cos(1000t)\ V$, $v_{s2}(t) = 7\cos(100t)\ V$, and $i_s(t) = 9mA$, use superposition to determine $i_x(t) = i_{x,s1}(t) + i_{x,s2}(t) + i_{x,s}(t)$.



Note: In this problem, you may only submit numerical answers. (i.e. If 4 is the correct answer, 4 will be marked as correct, but 2+2 will be marked as incorrect.)

a. $i_{x,s1}(t) =$ ____ $cos(10^3t+$ ____ $^\circ)mA$

b. $i_{x,s2}(t) =$ ____ $cos(100t+$ ____ $^\circ)mA$

c. $i_{x,s}(t) =$ ____ mA

Superposition
- Short V sources
- Open I sources

Vs1: $v_{s1} = 2$, $\omega = 1000$

KCL: $\frac{2-V_1}{450+400ms+400} + \frac{0-V_1}{200+650} = \frac{V_1}{1/0.4\mu s}$

$i_{x_1} = \frac{0-V_1}{650+200}$

→ solve: $i_{x_1} = 1.170247 \times 10^{-3} \angle 156.2247^\circ$

Vs2: $v_{s2} = 7$, $\omega = 100$

KCL: $\frac{0-V_1}{450+400ms+400} + \frac{0-V_1}{200+650} = \frac{V_1-7}{1/0.4\mu s}$

$i_{x_2} = \frac{0-V_1}{650+200}$

→ solve: $i_{x_2} = 1.401518 \times 10^{-4} \angle -89.62842^\circ$

Vs3: $i_s = 9m$, $\omega = 0$

KCL1: $\frac{V_1}{400} = \frac{V_2-V_1}{650}$

KCL2: $\frac{V_2-V_1}{650} = \frac{V_3-V_2}{200} + 9m$

KCL3: $0 = \frac{V_3-V_2}{200} + \frac{V_3}{450}$

$i_{x_3} = \frac{V_2-V_1}{650}$

→ solve: $i_{x_3} = 3.441176 \times 10^{-3} A$

$\because \omega = 0$, C ⊥ L

$i_x(t) = i_{x_1}(t) + i_{x_2}(t) + i_{x_3}(t)$