Name: _____ (please print)

Signature: _____

ECE 2202 – Quiz 4
July 29, 2020

Online

1. This quiz is open book, open notes.
2. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution which is not given in a reasonable order will lose credit.
3. Show all units in solutions, intermediate results, and figures. Units in the quiz will be included between square brackets.
4. If the grader has difficulty following your work because it is messy or disorganized, you will lose credit.
5. Do not use red ink. Do not use red pencil.
6. You will have 30 minutes to work on this quiz, and 15 minutes to download/print, scan and submit.

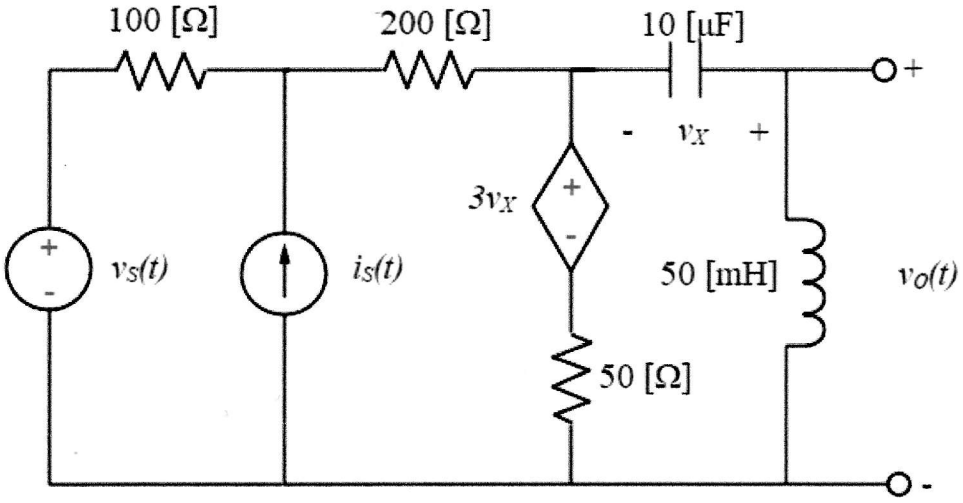
_____/25

Room for extra work

The circuit below is in steady state. The sources are given as follows.

$$v_S(t) = 15\ [\text{V}]\ \cos(1000[\text{rad/s}]t + 30^o) \qquad i_S(t) = 120\ [\text{mA}]\ \sin(2000[\text{rad/s}]t)$$

Find $v_O(t)$.



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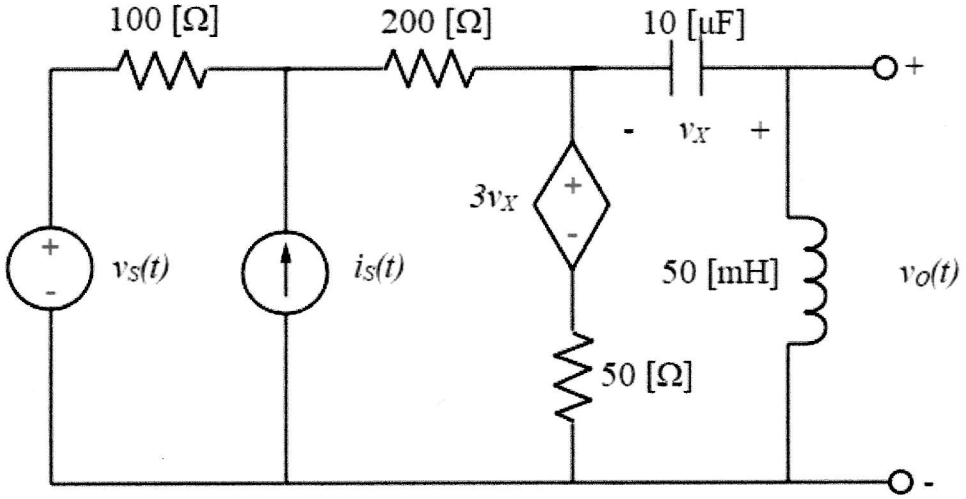
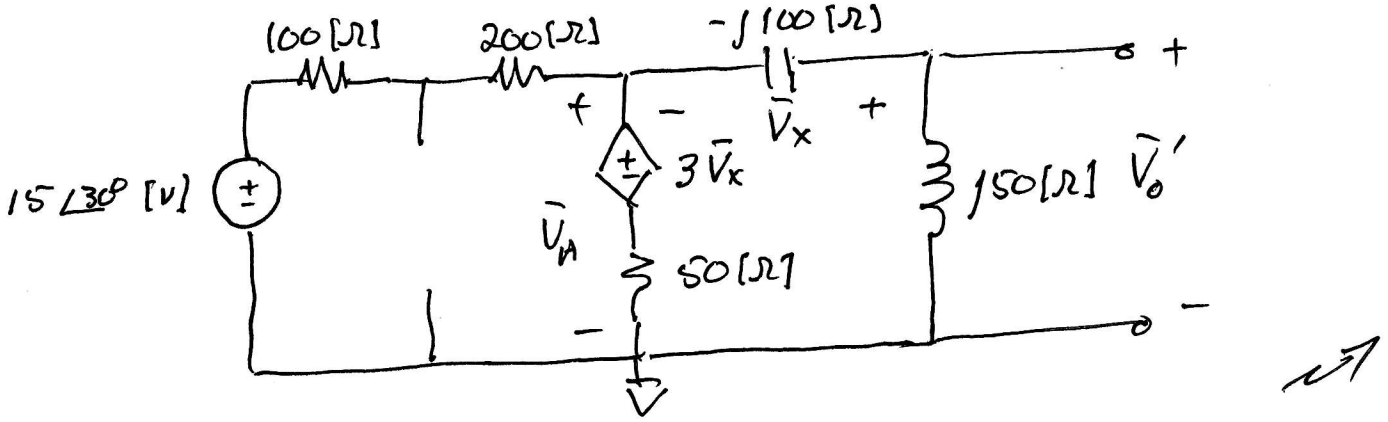


This is a phasor problem... the sources have different frequencies so we need superposition.

Consider $v_s(t)$ first $\Rightarrow$ $i_s(t) \rightarrow$ open, $\omega = 1000\ [\frac{\text{rad}}{\text{s}}]$

$50\ [\text{mH}] \rightarrow j\omega L = j(1000)(50\times10^{-3}) = j50\ [\Omega]$

$10\ [\mu\text{F}] \rightarrow -j/\omega C = -j/(1000)(10\times10^{-6}) = -j100\ [\Omega]$



Room for extra work

$$\frac{\bar{V}_A - 3\bar{V}_x}{50} + \frac{\bar{V}_A - 15\angle 30^\circ}{300} + \frac{\bar{V}_A}{-j100 + j50} = 0$$

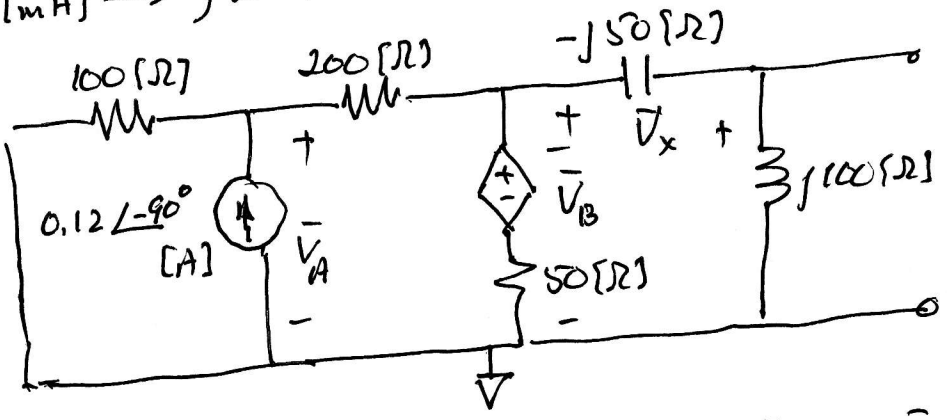
$$\bar{V}_x = -\bar{V}_A \frac{-j100}{-j100 + j50} = -2\bar{V}_A \qquad \bar{V}_o' = \bar{V}_A \frac{150}{-j100 + j50} = -\bar{V}_A$$

$$\bar{V}_A = 0.345\angle 22.06^\circ \text{ [V]} \qquad \boxed{\bar{V}_o' = -0.345\angle 22.06^\circ \text{ [V]}}$$

Now consider $i_s'(t) \Rightarrow v_o(t) \rightarrow$ short, $\omega = 2000 \left[\frac{rad}{s}\right]$

$$i_s'(t) = 0.12\text{[A]}\sin(2000t) = 0.12\text{[A]}\cos(2000t - 90^\circ)$$

$50\text{[mH]} \rightarrow j100\text{[}\Omega\text{]}$ $\quad 10\text{[}\mu\text{F]} \rightarrow -j50\text{[}\Omega\text{]}$



$$\frac{\bar{V}_A}{100} + \frac{\bar{V}_A - \bar{V}_B}{200} - 0.12\angle -90^\circ = 0 \qquad \bar{V}_x = -\bar{V}_B \cdot \frac{-j50}{j50} = \bar{V}_B$$

$$\frac{\bar{V}_B - \bar{V}_A}{200} + \frac{\bar{V}_B - 3\bar{V}_x}{50} + \frac{\bar{V}_B}{-j50 + j100} = 0 \qquad \bar{V}_o'' = \bar{V}_B \frac{j100}{j50} = 2\bar{V}_B$$

$$\bar{V}_B = 0.958\angle 61.34^\circ \text{ [V]} \qquad \boxed{\bar{V}_o'' = 1.916\angle 61.34^\circ \text{ [V]}}$$

We must convert $\bar{V}_o'$, $\bar{V}_o''$ to time domain separately, and add in the time domain:

$$v_o(t) = -0.345\cos(1000t + 22.06^\circ) + 1.916\cos(2000t + 61.34^\circ) \text{ [V]}$$