Name: ______________________________ (please print)

Signature: ___________________________

ECE 2300 – Quiz #6
July 21, 2016

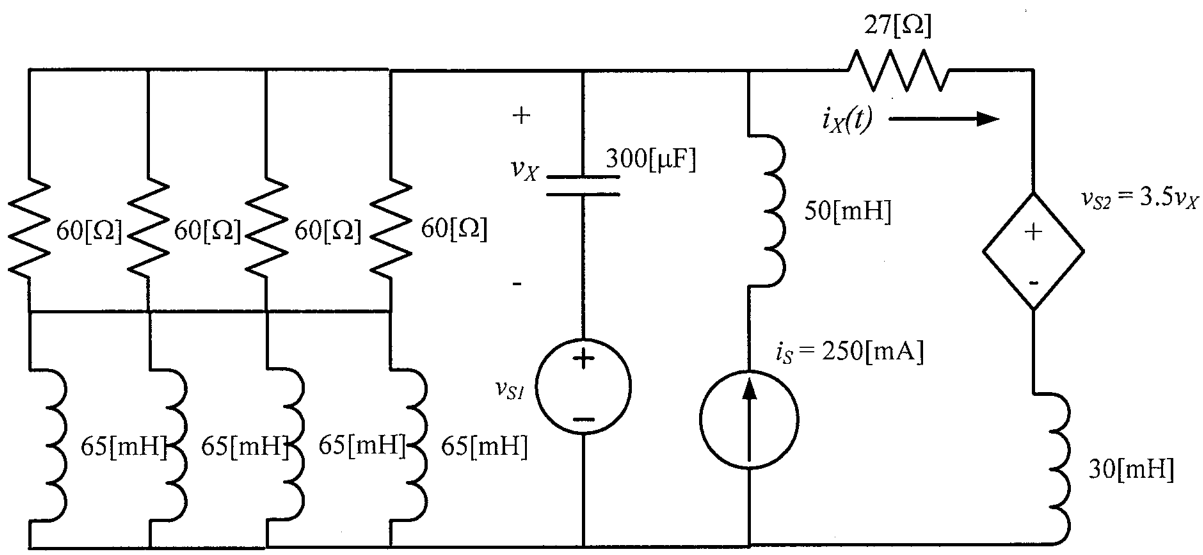
Keep this quiz closed and face up until you are told to begin.

1. This quiz is closed book, closed notes. You may use one 8.5" x 11" crib sheet, or its equivalent.
2. Show all work on these pages. 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.

________________/40

Room for extra work

In the circuit below, $v_{s1}(t) = 30\cos(377t + 20^{\circ})$ [V]. Find the steady state value of $i_X(t)$.



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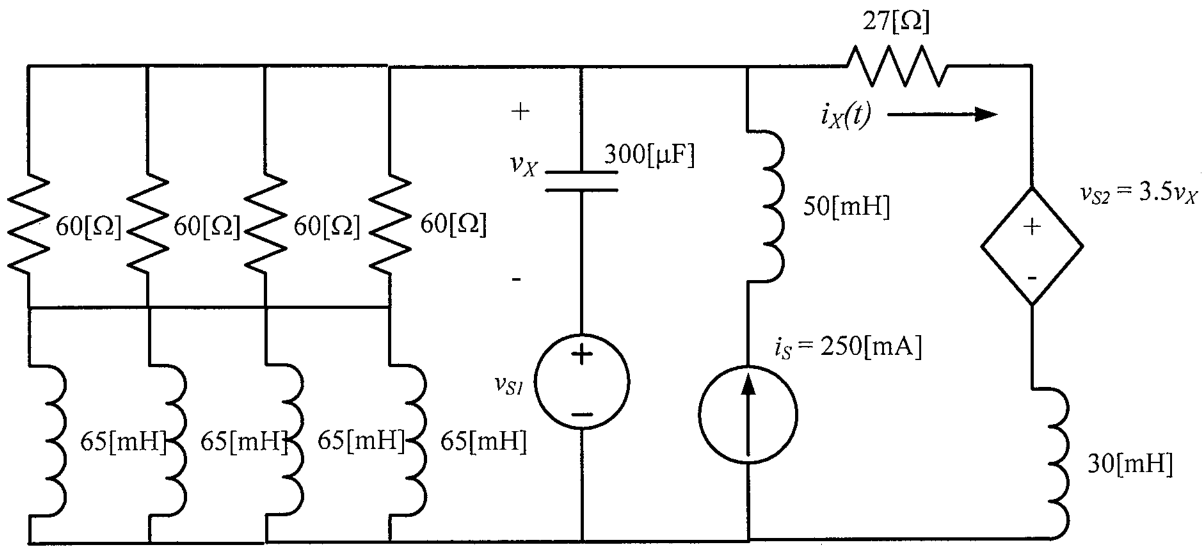


It seems clear that we want to simplify the network on the left:

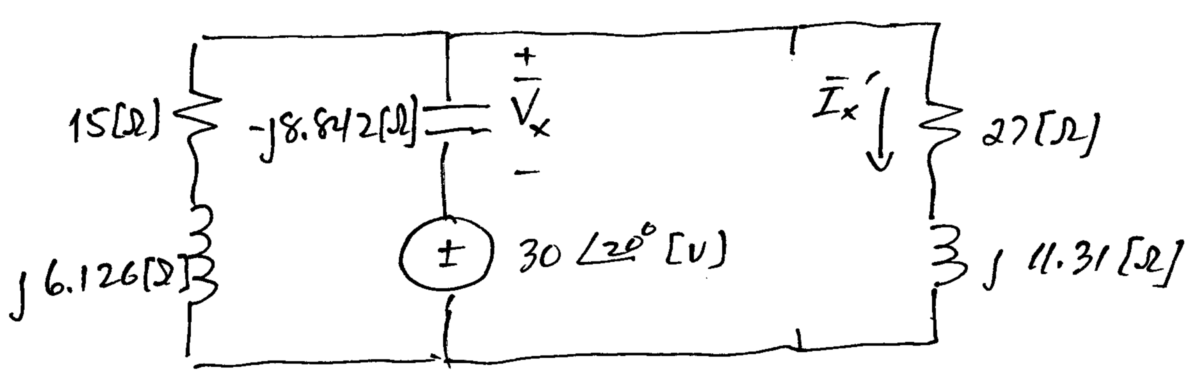
Four 60 [Ω] resistors in parallel is 15 [Ω].

Four 65 [mH] inductors in parallel is 16.25 [mH].

Next: We need superposition because our sources do not have the same frequency.

We treat v_{s1} first, in which case $i_s \to$ open circuit.

$\omega = 377$ [rad/s]



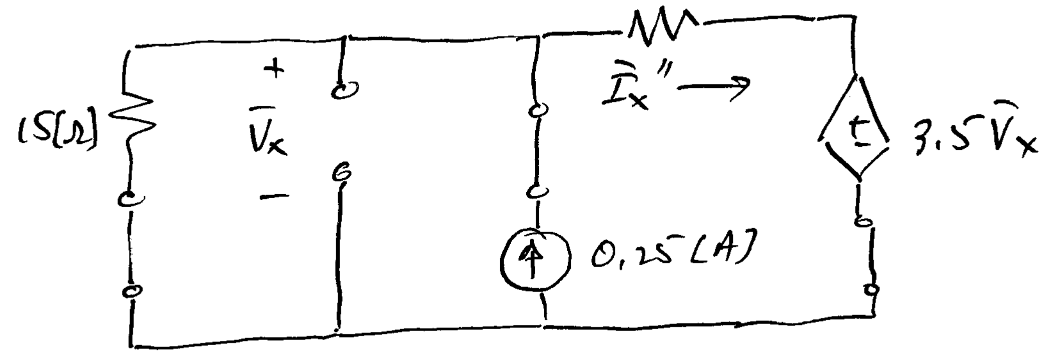
$$\frac{\bar{V}_x + 30\angle 20^\circ}{15 + j6.126} + \frac{\bar{V}_x}{-j8.842} + \frac{\bar{V}_x + 30\angle 20^\circ - 3.5\bar{V}_x}{27 + j11.31} = 0$$

Room for extra work $\hat{V}_x = 23.08 \angle 77.61^\circ$ [V]

$$\hat{I}_x' = \frac{\hat{V}_x + 30\angle 20^\circ - 3.5\hat{V}_x}{27 + j11.31} = 1.66 \angle -93.8^\circ \text{ [A]}$$

$$\therefore\ i_x'(t) = 1.66 \cos(377 [\tfrac{rad}{s}] t - 93.8^\circ) \text{ [A]}$$

The frequency of $i_s = 0$ so the capacitor is an open circuit and the inductors are shorts.



$$\frac{\hat{V}_x}{15} + \frac{\hat{V}_x - 3.5\hat{V}_x}{27} - 0.25 = 0 \Rightarrow \hat{V}_x = -9.643 \text{ [V]}$$

$$\bar{I}_x'' = \frac{\hat{V}_x - 3.5\hat{V}_x}{27} = 0.8929 \text{ [A]}$$

$$i_x'' = 0.8929 \text{ [A]}$$

So $i_x(t) = i_x'(t) + i_x''(t) = 1.66 \cos(377 [\tfrac{rad}{s}] t - 93.8^\circ) + 0.8929$ [A]