ECE 10, Winter 2023, Homework #7

Problem 1: Refer to the circuit in Figure 1. Use the loop current analysis method to determine $\underline{V}_O$ and the current delivered by the independent source.
(15 points)

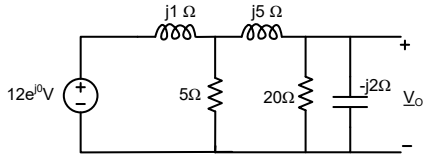

Figure 1

Problem 2: Refer to Figure 2 for this problem. Use node voltage analysis method to find $\underline{V}_C$ and $\underline{I}_N$. Assume $\underline{V}_S = 10$.

(15 points)

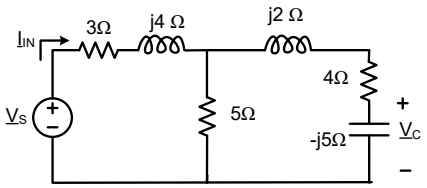

Figure 2

Problem 3: Refer to Figure 3. Considering sinusoidal steady state operation at 100 rad/s, and that L = 10H, answer the following questions.
(a) What is the phasor domain equivalent of the dependent source shown in the figure?
(b) What is the impedance looking into the terminals 1-1'?
(c) Draw a phasor diagram showing the phasors of $v_x(t)$, $i_{dep}(t)$, and $i_L(t)$ assuming that the phasor of $i_L(t)$ is $\underline{I}_L = j$.
(5 + 5 + 5 = 15 points)

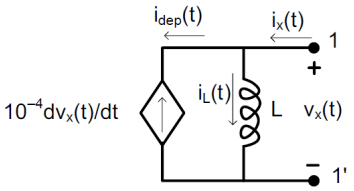

Figure 3

Problem 4: Refer to the circuit schematic shown in Figure 3 again, but now assume that a capacitor, C = 10μF, is in series with the network.
(a) Find the equivalent impedance, Z, of the combination in terms of the angular frequency, ω rad/s.
(b) Find the non-zero frequency, f, in Hz, at which the impedance Z is purely resistive. Note that $\omega = 2\pi f$.
(c) Suppose a sinusoidal voltage source, $v_S(t) = 2\cos(\omega t - \pi/6)$ Volts, where ω is the resonant frequency from part (b), is applied across the combination. Draw a phasor diagram showing the phasors of the voltage source, the voltage across the capacitor, $v_x(t)$, $i_{dep}(t)$, and $i_L(t)$.
(8 + 7 + 5 = 20 points)

Problem 5: Refer to the circuit schematic shown in Figure 4.
(a) Obtain the phasor domain representation for the circuit shown in the figure.
(b) Determine the phasors, $\underline{I}_B$, $\underline{I}_R$, $\underline{V}_L$, and $\underline{V}_A$, using the node voltage method with node N_C as the datum. Express all numerical phasor answers in polar form (i.e. in $re^{j\theta}$ form).
(c) Draw a complex plane "phasor" diagram showing $\underline{V}_S$, $\underline{I}_R$, $\underline{V}_L$, and $\underline{V}_A$. Indicate the angles and magnitudes of these phasors on the diagram.
(d) Determine the sinusoidal steady state expressions for $v_A(t)$. Does it lead or lag $v_S(t)$? By how many degrees?

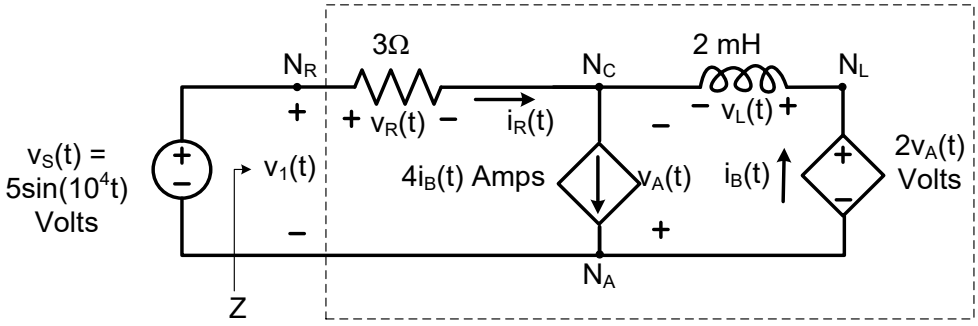

Figure 4

(5 + 10 + 5 + 5 = 25 points)

Problem 6: Refer to Figure 5 for this problem. What is the equivalent Norton's current source for sinusoidal steady state operation?

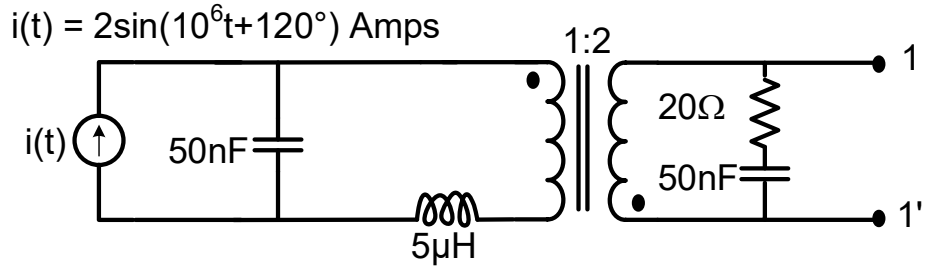

Figure 5

(10 points)