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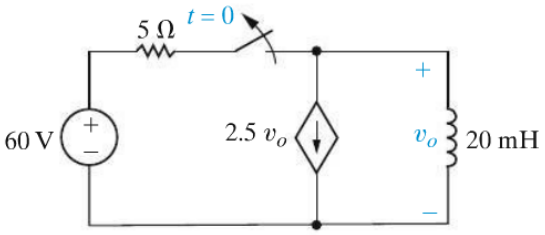
Name

Midterm Exam
Electric Circuit Analysis II
ECE222
February 11, 2016

Instructions: This exam is closed book, closed notes. You may have a single sheet of formulas (front and back) with no worked problems that you must turn in with your exam. By submitting your completed exam, you are attesting that you neither gave to, nor received help from anyone else.

Please sign this exam and turn in with your solutions, *but do not otherwise mark on this exam sheet.*

1) The switch in the circuit shown here has been closed for a long time before opening at t=0.



a) Sketch the circuit prior to opening of the switch and determine the initial inductor current, $i_L(0)$.

b) Sketch the circuit after opening of the switch and determine the final inductor current, $i_L(\infty)$.

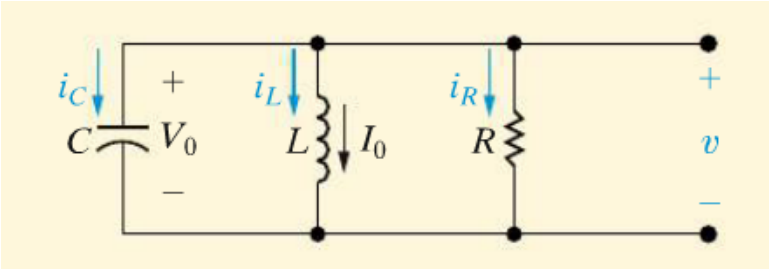
c) Determine (and sketch) the Thévenin equivalent circuit "seen" by the inductor after the switch is thrown.

d) Determine the inductor current, $i_L(t)$.

e) Calculate the output voltage, $v_o(t)$ for $t \geq 0^+$.

f) Sketch the inductor current, $i_L(t)$, and the output voltage, $v_o(t)$.

2) In solving for the natural response of a second order parallel RLC circuit (see figure at left),



your standard form for the voltage contains two unknowns. To determine these unknowns, you need two initial conditions. One is given by the initial voltage (if any) on the capacitor. How is the other initial condition determined? You must be complete and specific. In other words, you must specify the circuit law and provide the appropriate equation. Demonstrate the application of this constraint for the case of an overdamped system.

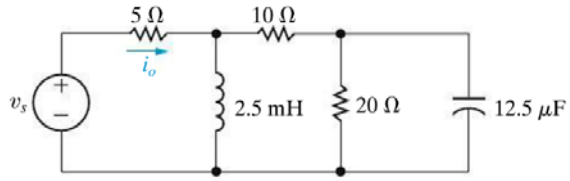
3) Find real numbers, *x* and *y* satisfying the following equation:

$$3x + 2jy - jx + 5y = 18 + 5j$$

4) Given: phasor voltage across a device of $20\angle 15^\circ$; current through the device of $2\angle 105^\circ$.
a) Sketch these phasors in the complex plane
b) Determine whether voltage leads or lags the current.
c) Identify the element.

5) The impedance of a circuit at a particular frequency is $4\,\Omega$ at a phase angle of -30°.
a) Sketch this impedance as a phasor in the complex plane.
b) What is the nature of this impedance? That is, is it resistive, inductive, or capacitive?
c) Determine the reactance of this circuit.
d) Will voltage or current lead, and by how much?

6) Illustrated here is a time-domain circuit operating in the steady state with source given by $v_g(t) = 20\sin(4000t)$.

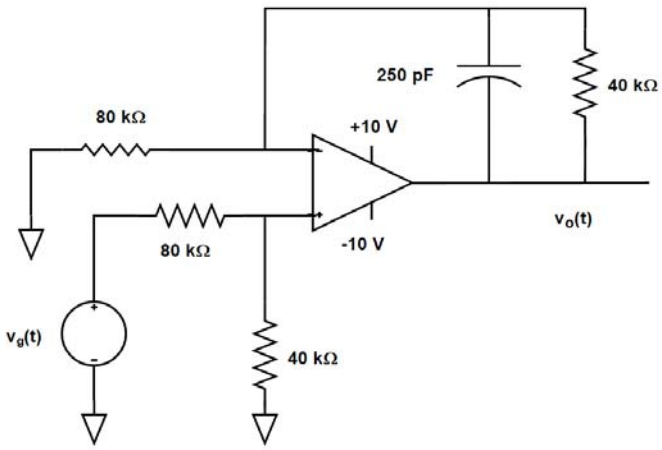


a) Sketch the frequency domain circuit.
b) Solve for the frequency domain phasor current, $\bar{I}_o$.
c) Give the time-domain voltage, $i_o(t)$.

7) The source signal for the ideal OpAmp circuit shown here is given by

$$v_g(t) = 18\cos(50,000t)\ \text{V}$$

a) Show the phasor transform of the source signal.
b) Sketch the circuit in the frequency (phasor) domain.
c) Write the nodal equations at the upper (inverting) and lower (non-inverting) terminals, denoting these voltages $\bar{V}_n$ and $\bar{V}_p$, respectively.
d) Make use of the ideal properties of the OpAmp to solve these nodal equations for the phasor domain output.
e) Perform the inverse phasor transform to show the time domain output.
f) Describe the function of the two-resistor combination at the non-inverting terminal of the OpAmp.



g) What does this circuit do? In other words, what function of the input is the output?