ECE 209 — Exam # 3

Estimated time for completion: <75 minutes
22 November 2016

Rules of the Exam

Rule 1: The examination period begins at 11:00pm on Tuesday 24 November 2015 and ends at 12:15pm on Tuesday 24 November 2015.

Rule 2: There are three problems.

Rule 3: Show all work and state all assumptions. Make sure to include the units along with a numerical answer. Answers without support when needed will not receive credit.

Rule 4: The exam is closed book and closed notes. You may have an 8.5" x 11" sheet of paper with notes. You may use a calculator.

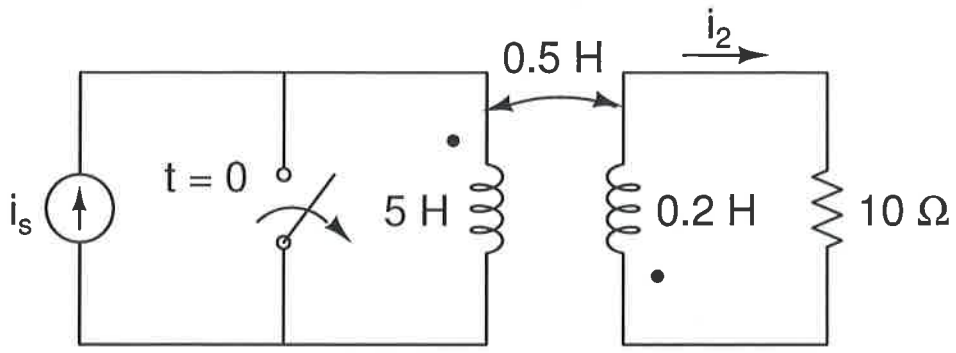
Answer Key

Name

Happy Thanksgiving!

Problem 1 (20 points)

In the circuit below, the switch has been closed for a very long time and opens at $t = 0$. There is no energy stored in the circuit at the time the switch opens.



What is $i_2(0^-)$ 0 A

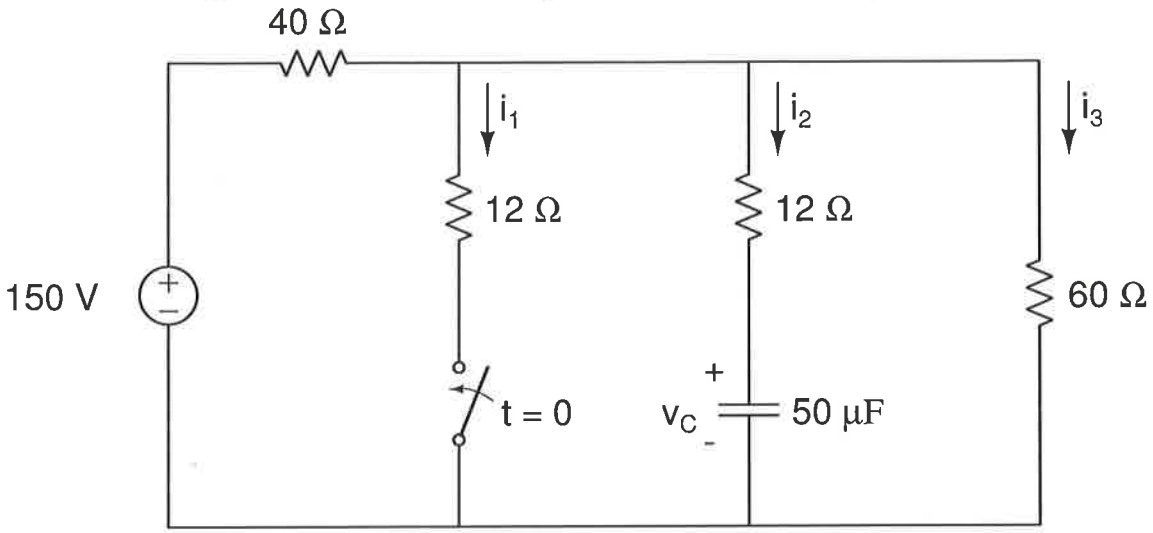
What is $i_2(0^+)$ 0 A

What is the differential equation that describes the behavior of $i_2(t)$ for $t \geq 0$? (Note: you do not need to solve the equation.)

$$10 i_2 + 0.2 \frac{di_2}{dt} + 0.5 \frac{di_s}{dt} = 0$$

Problem 2 (40 points)

In the circuit below, the switch has been open for a very long time and closes at $t = 0$.



60//12//40 = 8 + 12 = 20 Ω

What is the time constant of the circuit for $t > 0$? 1 ms

RC

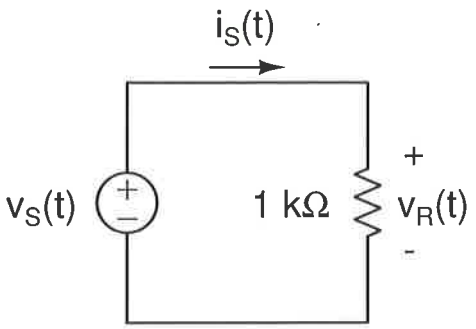
See page 6

Complete the table below:

	$t = 0^-$	$t = 0^+$	$t = 4$ ms	$t = \infty$
i_1	0 A	4.5 A	2.54A	2.5A
i_2	0 A	-3.0	-0.055 A	0A
i_3	1.5A	0.9A	0.507A	0.5A
v_C	90 V	90 V	31.1 V	30V

Problem 3 (40 points)

Part A. For the circuit below the voltage source $v_s(t) = 150\cos(2513t - 55°)$ V



What is the peak voltage across the resistor? 150V

What is $v_S(4\text{ms})$? -141.77 V

What is $i_S(4\text{ms})$? -141.77 mA

What is the frequency of $V_R(t)$ in Hz? 400 Hz

What is the average power dissipated by the resistor? 11.25 W

Part B. What is the Phasor representation of the following time-domain signals?

$v(t) = 120\cos(360t - 37°)$ mV $\quad 120\angle -37°$ mV

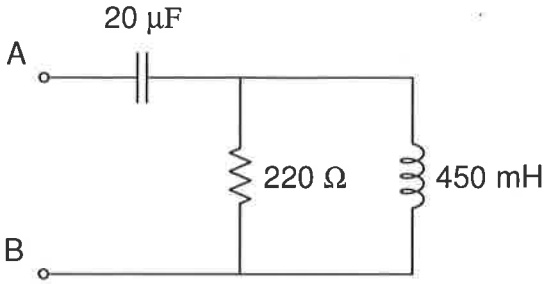
$i(t) = 75\sin(450t + 40°)$ A $\quad 75\angle -50°$ A

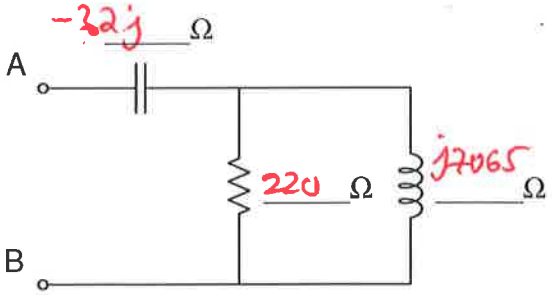
Part C. What is the time-domain representation of the following Phasor signals when the frequency is 3 MHz?

$\mathbf{V} = 25\angle -50°$ V $\quad 25\cos(6\pi\times10^6 t - 50°)$ V ✓

$\mathbf{I} = 0.3\angle 15°$ A $\quad 0.3\cos(6\pi\times10^6 t + 15°)$ A

Part D. Convert the circuit below on the left to the frequency domain when the frequency is 2.5 kHz.





Frequency Domain

At what radian frequency, ω, is the impedance Z_{AB} purely resistive? 333.3 rad/s

$$Z_{AB} = \frac{-j}{\omega C} + \frac{220 \times j\omega L}{220 + j\omega L}$$

$$= \frac{-j}{\omega C} + \frac{220\, j\omega L\,(220 - j\omega L)}{220^2 + \omega^2 L^2}$$

$$\mathrm{Im}(Z_{AB}) = \frac{-j}{\omega C} + \frac{(220)^2 j\omega L}{(220)^2 + \omega^2 L^2} = 0$$

$$\Rightarrow -(220)^2(\omega^2 L^2) + (220)^2 \omega^2 LC = 0$$

$$\omega^2 (220^2 LC - L^2) = 220^2$$

$$\omega = \frac{220}{\sqrt{220^2 LC - L^2}}$$

$$= 333.3 \text{ rad/s}$$

$$-\frac{j}{\omega C} + R \# j\omega L$$

$$-\frac{j}{\omega C} + \frac{j\omega LR}{R + j\omega L}\,\frac{R - j\omega L}{R - j\omega L}$$

$$-\frac{j}{\omega C} + \frac{j\omega LR^2 + \omega^2 L^2 R}{R^2 + \omega^2 L^2}$$

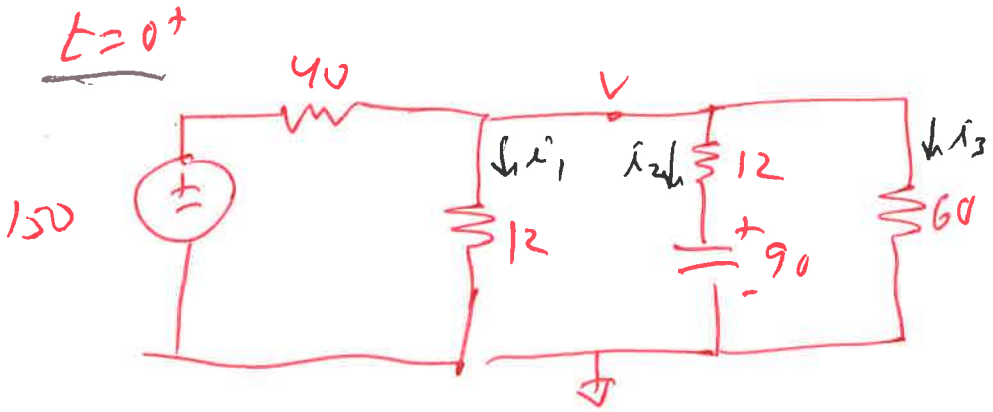
$$-\frac{1}{\omega C} + \frac{\omega LR^2}{R^2 + \omega^2 L^2} = 0$$

$$-R^2 - \omega^2 L^2 + \omega^2 LCR^2 = 0$$

$$\omega^2 (LCR^2 - L^2) = R^2$$

$$\omega^2 = \frac{R^2}{(LCR^2 - L^2)}$$

Name: _____



$$\frac{V-150}{40}+\frac{V}{12}+\frac{V}{60}+\frac{V-90}{12}=0$$

$$V=54V$$

i_1: $2.5+[4.5-25]e^{-4} = 2.537\ A$

i_2 $-3e^{-4} = -0.055\ A$

i_3 $0.5+[0.9-0.5]e^{-4} = 0.507\ A$

v_c $30+60e^{-4} = 31.1\ V$

Name: _____