ECE 209 — Exam # 3

Estimated time for completion: <75 minutes
22 November 2016

Rules of the Exam

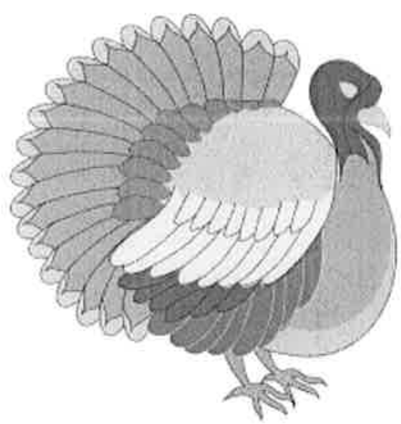
Rule 1: The examination period begins at 11:00pm on Tuesday 24 November 2015 and ends at 12:15pm on Tuesday 24 November 2015.

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.

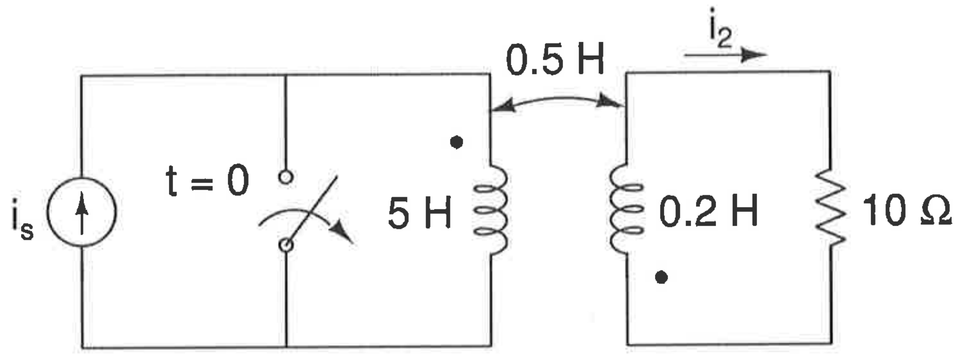
Answer Key
Name



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___

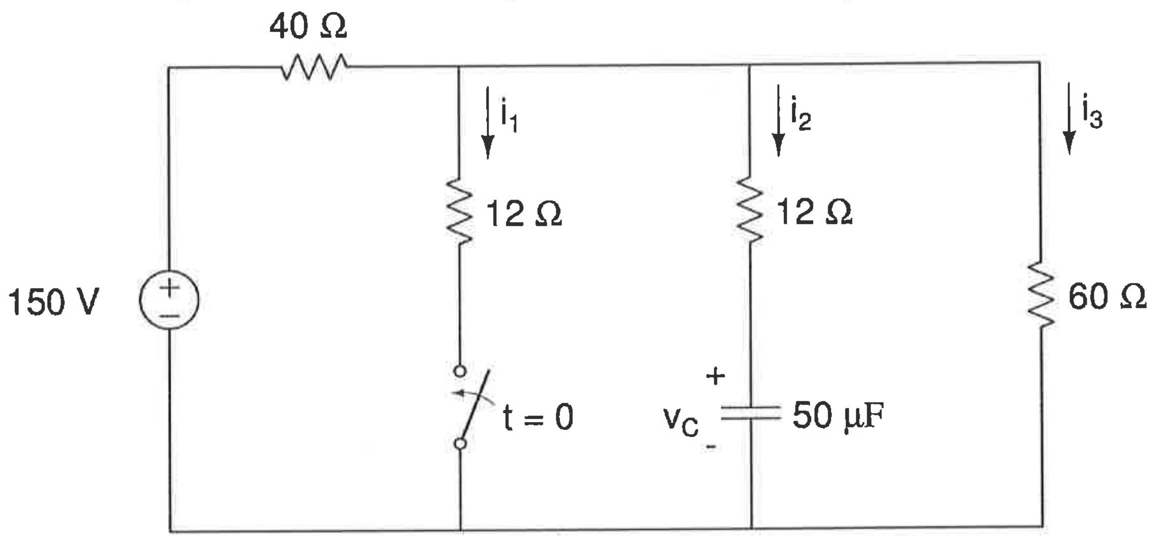
What is $i_2(0^+)$ ___0 A___

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 $t = 0$.



R_{Th} seen by capacitor: $60 \| 12 \| 40 + 12 = 20\Omega$

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

See Page 6

Complete the table below:

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

@ t = 4ms

$i_1 = 2.5 + [4.5 - 2.5]e^{-4} = 2.54A$

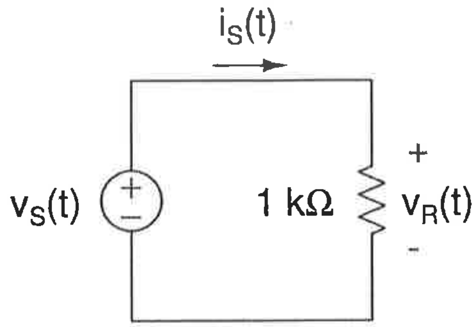
$i_3(4ms) = 0.5 + [0.9 - 0.5]e^{-4} = 0.507A$

$i_2(4ms) = -3e^{-4} = -0.055A$

$v_C(4ms) = 30 + 60e^{-4} = 31.1V$

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? 150 V

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

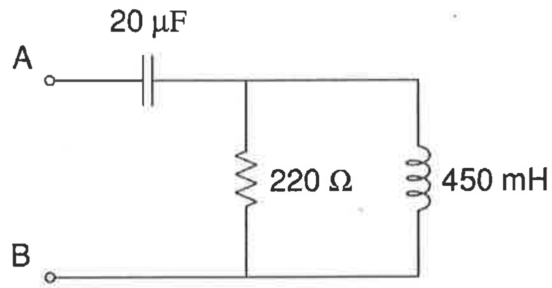
$i(t) = 75\sin(450t + 40°)$ A $\quad$ $75\angle{-50°}$ A

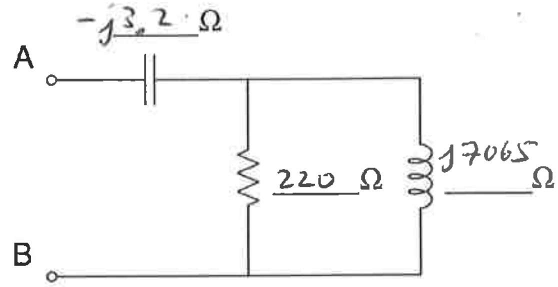
Part C. What is the time-domain representation of the following Phasor signals when the frequency is 3 MHz?

$\mathbf{V} = 25\angle -50°$ V $\quad$ $25\cos(6\pi \times 10^6 t - 50°)$ V

$\mathbf{I} = 0.3\angle 15°$ A $\quad$ $0.3\cos(6\pi \times 10^6 t + 15°)$ 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? 456 rad/s

$$Z_{AB} = \frac{-j}{\omega C} + R \| j\omega L$$

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

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

For Z_{ab} to be purely resistive: $\frac{-j}{\omega C} + \frac{j\omega L R^2}{R^2 + \omega^2 L^2} = 0$

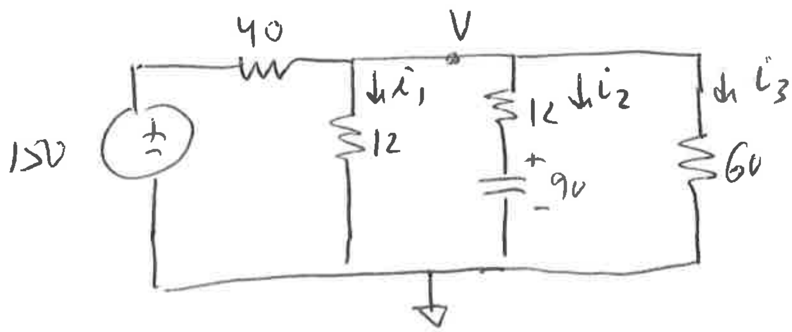
$$\omega^2 L C R^2 - R^2 - \omega^2 L^2 = 0$$

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

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

$$\omega = \frac{R}{\sqrt{L C R^2 - L^2}}$$

@ $t = 0^+$



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

$V = 54V$

$i_1 = \frac{V}{12}$

$i_2 = \frac{V-90}{12}$

$i_3 = \frac{V}{60}$