ECE 100 (Spring 2021) - Quiz #2

(Format: 2 questions, 50 minutes)

Name: ______________________________

Student ID: __________________________

Score: _______ out of 50

Instructions:

1. Register for the quiz (if you are seeing this, you should have already registered)
2. Once you register for the midterm, you will have 50 minutes to complete Quiz #2.
3. After the midterm, you have 15 minutes to submit and upload your quiz to CCLE (under “Week 8 → Quiz #2”).
4. Please fill out this ‘End-of-Quiz’ survey to acknowledge that you have completed the quiz and submitted your answer sheet to CCLE: https://forms.gle/ygYR56REKELkUXoE6

Rules:

- Quiz is closed book. No computers, cell phones, etc.
- 1-page cheat sheet
- Scientific calculator allowed.
- Box all of your answers & show your work.
- **If you have questions on the exam, please DO NOT post on Piazza. Email instructor(s) directly.**

Quiz Start Time:

Wednesday, May 19th @ 6:00pm PDT

Note: Once you register for the quiz, you will have 1h 5m to complete & upload your results. (50 minutes to take the exam, 15 minutes to upload).

End Time:

Thursday, May 20th @ 5:59pm PDT (answer sheet must be submitted by this time)

No late submissions

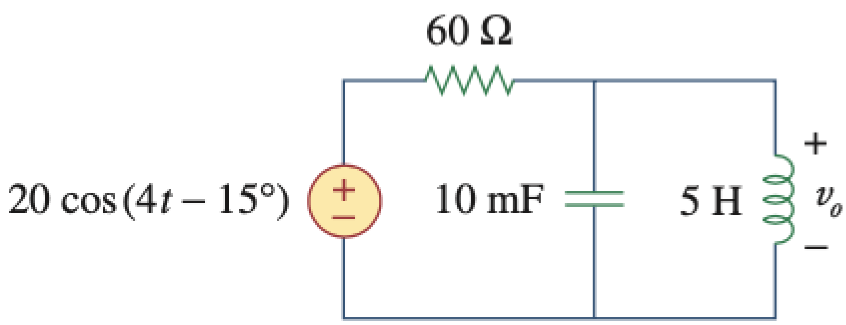
Problem 1: Phasors (15 points)

(a) Given $i_1(t) = 4cos(\omega t + 30°)$**and** $i_2(t) = 5sin(\omega t - 20°)$**, solve for** $i_T(t) = i_1(t) + i_2(t)$**.** *(4 points)*

(b) Using the phasor approach, determine the current i(t) in a circuit described by the following 2nd order differential equation. *(5 points)*

$$4i + 8\int i\,dt - 3\frac{di}{dt} = 50\cos(2t + 75°)$$

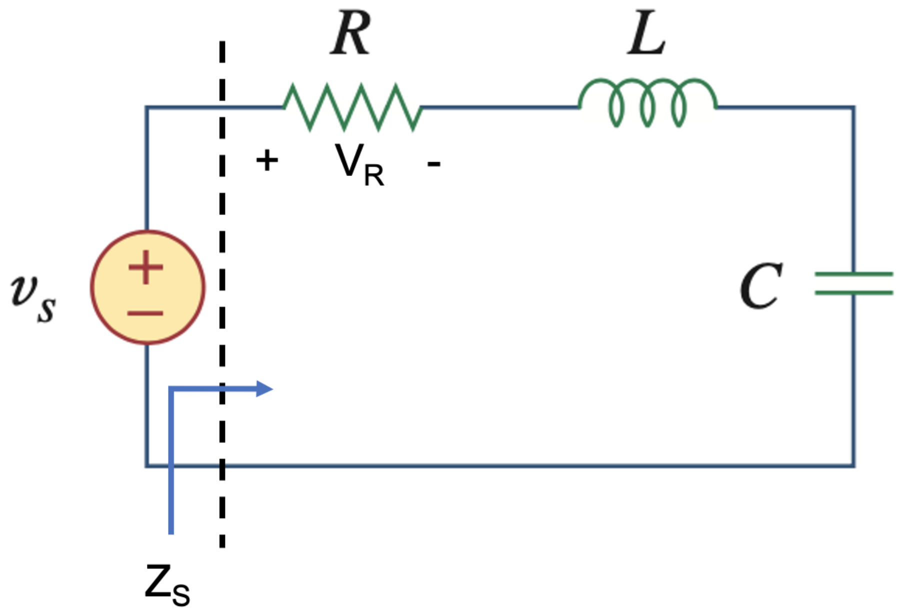
(c) Determine $v_o(t)$**in the following circuit.** *(5 points)*



(d) What type of filter can be constructed using the circuit topology shown in part (c)? *(1 point)*

Problem 2: Resonance (35 points)

Consider the series RLC circuit shown below. The source voltage is given as $V_S(t) = V_m sin(\omega t)$.



(a) Solve for the voltage $V_R(t)$ in the time domain using 2nd order differential equations. You may neglect the complementary solution.
(4 points)
Hint: Start by writing the differential equation for the current flowing through the circuit, i(t). Neglecting the complementary solution, you may consider a particular solution of the form $i_p(t) = A \times e^{j\omega t}$.

(b) Solve for the voltage $V_R(t)$ using the concept of phasors and complex impedances. *(4 points)*

(c) Solve for the impedance seen by the source, Z_s. *(2 points)*

(d) Derive for the transfer function, $H(j\omega) = V_R(j\omega)/V_S(j\omega)$**.** *(3 points)*

(e) Write a set of expressions that describes the magnitude, $|H(j\omega)|$**, and phase** $\angle H(j\omega)$ **of the transfer function derived in (d).** *(3 points)*

(f) Draw the Bode plot of the transfer function. Show both magnitude and phase plots on two separate graphs. *(3 points)*

(g) What is the resonant angular frequency, ω_o**?** *(2 points)*

(h) What is the output phase with respect to the input phase at resonance $(\omega = \omega_o)$**?** *(2 points)*

(i) What is the quality factor, Q_S, of this circuit? *(2 points)*

(j) What is the 3dB bandwidth of this circuit? *(2 points)*

(k) Plot $V_R(t)$ considering the following excitation: *(3 points)*

$for\ t < 0:\ V_S(t) = V_m sin(\omega t)$

$for\ t \geq 0:\ V_S(t) = 0$

(l) What is the energy stored in the first cycle (at t>0)? What is the energy during the second cycle? *(3 points)*

Hint: Consider a damped oscillation with an envelope of $e^{-\alpha t} = e^{-t/\tau}$ *where* $\alpha = \frac{1}{\tau} = \frac{\omega_o}{2Q_s}$ *(*α *is also related to the damping coefficient:* $\alpha = \frac{1}{\tau} = \zeta\omega_o$*).*

(m) How do you relate this to the quality factor of the circuit? *(2 points)*