ECE 201 – Spring 2011
Exam #3
Thursday, April 14, 2011

Division 0101: Prof. Tan (9:30am); Division 0201: Prof. Tan (10:30 am)
Division 0301: Prof. Jung (7:30 am); Division 0401: Prof. Capano (11:30am)

Instructions

1. DO NOT START UNTIL TOLD TO DO SO.

2. Write your Name, division, professor, and student ID# (PUID) on your scantron sheet.

3. This is a CLOSED BOOKS and CLOSED NOTES exam.

4. There is only one correct answer to each question.

5. Calculators are allowed.

6. If extra paper is needed, use back of test pages.

7. Cheating will not be tolerated. Cheating in this exam will result in an F in the course.

8. If you cannot solve a question, be sure to look at the other ones and come back to it if time permits.

9. As described in the course syllabus, we must certify that every student who receives a passing grade in this course has satisfied each of the course outcomes. On this exam, you have the opportunity to satisfy outcomes iii, iv, v and ix. (See the course syllabus for a complete description of each outcome.) On the chart below, we list the criteria we use for determining whether you have satisfied these course outcomes. If you fail to satisfy any of the course outcomes, don’t panic. There will be more opportunities for you to do so.

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10. You will find formulas on the final page of this exam. You can tear the page out if you want to.
1. At \( t = 0 \) sec, the inductor current is \( i_L(0^+) = 0 \) A and the capacitor voltage is \( v_c(0^+) = 4 \) V. Find \( v_c(t) \) for \( t \geq 0 \) s (in V).

\[
\begin{align*}
\text{(1)} & & v_c(t) = 2 \cos(5 \times 10^3 t) \\
\text{(2)} & & v_c(t) = 2 \cos(25 \times 10^6 t) \\
\text{(3)} & & v_c(t) = 2 \sin(5 \times 10^3 t) \\
\text{(4)} & & v_c(t) = 2 \sin(25 \times 10^6 t) \\
\text{(5)} & & v_c(t) = 4 \cos(5 \times 10^3 t) \\
\text{(6)} & & v_c(t) = 4 \cos(25 \times 10^6 t) \\
\text{(7)} & & v_c(t) = 4 \sin(5 \times 10^3 t) \\
\text{(8)} & & v_c(t) = 4 \sin(25 \times 10^6 t)
\end{align*}
\]

2. Find the resistance, \( R \) (in \( \Omega \)), which makes the roots of the characteristic equation \( s^2 + bs + c = 0 \) to be identical for circuits (a) and (b) below.

\[
\begin{align*}
\text{(1)} & & 1 \\
\text{(2)} & & 2 \\
\text{(3)} & & 3 \\
\text{(4)} & & 4 \\
\text{(5)} & & 5 \\
\text{(6)} & & 6 \\
\text{(7)} & & 7
\end{align*}
\]
3. The switch in the RLC circuit below has been closed for a long time. It opens at \( t = 0 \), and remains open for \( t > 0 \). Find the capacitor current \( i_C(0^+) \) and the inductor voltage \( v_L(0^+) \) at \( t = 0^+ \).

![RLC Circuit Diagram]

(1) 8 A and 6 V  (2) 2 A and 8 V  (3) 4 A and 12 V  (4) 4 A and 6 V  
(5) 0 A and 2 V  (6) 6 A and 12 V  (7) 0 A and 4 V  (8) 6 A and 8 V

4. The inductor current response for the circuit below is \( i_L(t) = [20 - 160t]e^{-20t} \) for \( t \geq 0 \) sec. Find the initial condition \( v_C(0^-) \) in V.

![Inductor Circuit Diagram]

(1) \(-36\)  (2) \(-24\)  (3) \(-12\)  (4) 0  
(5) 12  (6) 24  (7) 36  (8) 48
5. In the ideal OpAmp circuit shown below, find the value of R (in kΩ) so that the gain \( V_{\text{out}}/V_{\text{in}} = -100 \).

![OpAmp Circuit Image]

\[
(1) 0.001 \\ (2) 0.01 \\ (3) 0.1 \\ (4) 1 \\ (5) 10 \\ (6) 100 \\ (7) 1,000 \\ (8) 10,000
\]

6. Determine the Thevenin equivalent resistance, \( R_{TH} \) (in Ω), for the ideal OpAmp circuit below.

![OpAmp Circuit Image]

\[
(1) 1 \\ (2) 2 \\ (3) 3 \\ (4) 4 \\ (5) 5 \\ (6) 6 \\ (7) 7 \\ (8) 8
\]
7. Find $v_o(t)$ (in V) for $t \geq 0$ in the circuit below assuming ideal OpAmp behavior and $v_c(0^-) = 3$ V.

![Circuit Diagram](image)

(1) $12 - 6e^{-5t}$  (2) $6 - 3e^{-2t}$  (3) $3 - 3e^{-2t}$  (4) $4 - 2e^{-t}$  
(5) $3 - 3e^{-5t}$  (6) $6 - 3e^{-5t}$  (7) $15 - 5e^{-5t}$  (8) $4 - 2e^{-2t}$

8. In the ideal OpAmp circuit shown below, find $v_{out}$ (in V).

![Circuit Diagram](image)

(1) 1  (2) 2  (3) 3  (4) 4  
(5) $-1$  (6) $-2$  (7) $-3$  (8) $-4$
9. In the ideal OpAmp circuit shown below, find $v_{out}(t)$.

(1) $1 \cdot \sin(t)$  
(2) $-1 \cdot \sin(t)$  
(3) $100 \cdot \sin(t)$  
(4) $-100 \cdot \sin(t)$  
(5) $1 \cdot \cos(t)$  
(6) $-1 \cdot \cos(t)$  
(7) $100 \cdot \cos(t)$  
(8) $-100 \cdot \cos(t)$

10. Assume the circuit shown below is operating in sinusoidal steady state with angular frequency $\omega$. For what $\omega$ (in rad/sec) do $v_{in}$ and $i_{in}$ have the same phase?

(1) 0.25  
(2) 0.5  
(3) 0.75  
(4) 1  
(5) 1.25  
(6) 1.5  
(7) 1.75  
(8) 2
11. For the RLC network shown below, find its equivalent impedance $Z_{eq}$ (in $\Omega$).
Assume $\omega = 100$ rad/sec.

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Assume $\omega = 100$ rad/sec.

(1) 40                (2) 40 + j100
(5) 50 + j100          (6) 50 – j100
(3) 40 – j100          (4) 50
(7) 60                (8) 60 + j100

12. Find the current $i_s(t)$ (in A) supplied by the source in the circuit below, assuming sinusoidal steady state and $\omega = 3$ rad/sec.

(1) 0.5 cos (3t + 36.9°)  (2) 2.5 cos (3t + 53.1°)
(3) 5.0 cos (6t + 53.1°)  (4) 0.5 cos (3t + 53.1°)
(5) 2.5 cos (3t + 36.9°)  (6) 5.0 cos (3t + 53.1°)
(7) 2.5 cos (6t + 36.9°)  (8) 0.5 cos (6t + 36.9°)
13. Find the phasor $V_1$ (in $V$) assuming $\omega = 1$ rad/sec.

\[ V_{s1} = 10 \angle 90^\circ V \]

\[ + v_c(t) - \]

\[ V_1 \]

\[ 1 \Omega \]

\[ 1 F \]

\[ V_{s2} = 5 \angle 0^\circ V \]

(1) $5 \angle 45^\circ$
(2) $7.07 \angle 63.4^\circ$
(3) $3.53 \angle 0^\circ$
(4) $-7.07 \angle 26.6^\circ$
(5) $5 \angle 0^\circ$
(6) $3.53 \angle 63.4^\circ$
(7) $7.07 \angle 45^\circ$
(8) $-5 \angle 0^\circ$

14. The circuit shown below is in sinusoidal steady state. The input is $v_s(t) = 60 \cos(\omega t)$ V. At $\omega = \infty$ rad/sec, $i_s(t) = 15 \cos(\omega t)$ A. At $\omega = 0$ rad/sec, $i_s(t) = 12 \cos(\omega t)$ A. Find the values of $R_1$ (in $\Omega$).

\[ v_s(t) \]

\[ i_s(t) \]

\[ + \]

\[ C \]

\[ R_1 \]

\[ R_2 \]

\[ L \]

\[ v_s(t) \]

(1) 1
(2) 2
(3) 3
(4) 4
(5) 5
(6) 6
(7) 7
(8) 8
Potentially Useful Formulas

\[ x(t) = x(\infty) + \left[ x(t_0^+) - x(\infty) \right] e^{-t/t} \]

\[ \tau = L/R \]

\[ \tau = RC \]

\[ x(t) = x(\infty) + (A \cos \omega_d t + B \sin \omega_d t) e^{-\sigma t} \]

\[ x(t) = x(\infty) + (A + Bt) e^{-\sigma t} \]

\[ x(t) = x(\infty) + \left( A e^{s_1 t} + B e^{s_2 t} \right) \]

\[ s_1, s_2 = \frac{-b \pm \sqrt{b^2 - 4c}}{2} \text{ for } s^2 + bs + c = 0, \text{ where } c = (LC)^{-1} \]

\[ \sigma = b = \begin{cases} \frac{R}{2L} \quad \text{(series)} \\ \frac{1}{2RC} \quad \text{(parallel)} \end{cases} \]

\[ \omega_o = \frac{1}{\sqrt{LC}} \]

\[ s_{1,2} = -\sigma \pm \sqrt{\sigma^2 - \omega_o^2} \]

\[ \omega_d = \frac{\sqrt{4c - b^2}}{2} = \sqrt{\omega_o^2 - \sigma^2} \]