Closed book/notes, calculators allowed up to level of TI89, TI Inspire, HP50.

Part I: 6 questions
Part II: 6 questions
Part II is worth twice as much as Part I

On the SCANTRON write and bubble-in your:

1. Name (Last, first)

2. Write the color of your exam paper (IVORY or GREEN) on the top left margin of the SCANTRON.

Show your UofA picture ID card when you turn in your exam.

All work should be done on the examination paper. Allow for reasonable amounts of roundoff error, and carefully mark one choice for each problem on the SCANTRON answer sheet.

All answer sheets and examinations will be collected at 10:30. You will be asked to stop writing and hand in your papers/answer sheets. Failure to comply promptly may result in disqualification from the exam.

NAME: _________________________________

SIGNATURE: ___________________________
Formula Sheet for Exam #4 and Final Exam

\[ x(t) = x(\infty) + A_1 e^{s_1(t-t_0)} + A_2 e^{s_2(t-t_0)} \]
\[ x(t_0) = x(\infty) + A_1 + A_2 \]
\[ x'(t_0) = s_1 A_1 + s_2 A_2 \]

\[ x(t) = x(\infty) + (B_1 \cos[\omega_d(t-t_0)] + B_2 \sin[\omega_d(t-t_0)]) e^{-\alpha(t-t_0)} \]
\[ x(t_0) = x(\infty) + B_1 \]
\[ x'(t_0) = -\alpha B_1 + \omega_d B_2 \]

\[ x(t) = x(\infty) + [D_1(t-t_0) + D_2] e^{-\alpha(t-t_0)} \]
\[ x(t_0) = x(\infty) + D_2 \]
\[ x'(t_0) = D_1 - \alpha D_2 \]

\[ s_1, s_2 = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2} \]

Parallel RLC
\[ \alpha = \frac{1}{2RC} \]

Series RLC
\[ \alpha = \frac{R}{2L} \]
Part I.

1. Given that $v(t) = 4 \text{ V}$ at $t = 20 \text{ ms}$, when will $v(t)$ reach approximately $0 \text{ V}$?

   a) $t = 20 \text{ ms}$
   b) $t = 60 \text{ ms}$
   c) $t = 100 \text{ ms}$
   d) $t = 120 \text{ ms}$
   e) none of these

2. The switch has been in its initial position a long time before moving at $t = 0$. Given $v(0) = 2 \text{ V}$, find $i(0^+)$.  

   a) $1 \text{ mA}$
   b) $2 \text{ mA}$
   c) $3 \text{ mA}$
   d) not enough information given
   e) none of these

3. The switch has been closed a long time before opening at time $t = 4 \text{ ms}$. Find $v(\infty)$. 

   a) $-4 \text{ V}$
   b) $4 \text{ V}$
   c) $-6 \text{ V}$
   d) $6 \text{ V}$
   e) none of these
4. The switch has been closed a long time before opening at time $t = 4 \text{ ms}$. What is the energy stored in the capacitor at time $t = 4^+ \text{ ms}$?

a) 4 $\mu$J  
b) 16 $\mu$J  
c) 36 $\mu$J  
d) 100 $\mu$J  
e) none of these

5. Find the characteristic roots $s_1$ and $s_2$.

a) $-0.08 \pm j0.3$  
b) $-0.5 \pm j0.3$  
c) $-0.2$ and $-0.8$  
d) $-0.05$ and $-0.13$  
e) none of these

6. The following differential equation corresponds to a circuit that is

\[ \frac{d^2x(t)}{dt^2} + 2 \frac{dx(t)}{dt} + x(t) = 9 \]

a) undamped  
b) underdamped  
c) critically damped  
d) overdamped  
e) none of these
Part II.

7. The switch has been closed for a long time before opening at \( t_0 = 0 \) ms. Find \( v(t) \) for \( t = 15 \) ms.

\[ v(t) = \frac{12}{2 + 2} \]

a) 3.79 V  
b) 7.59 V  
c) 0.95 V  
d) 1.90 V  
e) none of these
8. The switch has been closed for a long time before opening at \( t = 0 \). Find \( i(t) \) for \( t = 4 \) μs.

   a) 0.57 mA
   b) 1.14 mA
   c) 2.27 mA
   d) 4.54 mA
   e) none of these
9. Given that \( i(0^-) = 2 \, mA \) and \( v(0^-) = 3 \, V \), find \( i'(0^+) \).

\[ \begin{align*}
\text{a)} & \quad 0.25 \, kA/s \\
\text{b)} & \quad -0.67 \, kA/s \\
\text{c)} & \quad 1.00 \, kA/s \\
\text{d)} & \quad -2.00 \, kA/s \\
\text{e)} & \quad \text{none of these}
\end{align*} \]
10. Given that \( i(0^-) = 2 \) mA and \( v(0^-) = 3 \) V, find \( i'(0^+) \).

a) 0.25 kA/s  
b) \(-0.67\) kA/s  
c) 1.00 kA/s  
d) \(-2.00\) kA/s  
e) none of these
11. The switch has been in the position shown for a long time prior to moving at $t = 0$. Given $v'(0^+) = 0 \text{ V/s}$, find the constant $B_2$ required in the solution for $v(t)$.

a) 2
b) 4
c) 6
d) 8
e) none of these
12. Given $v(0^-) = 2 \text{ V}$, $i(0^-) = 0$, $i'(0^+) = 500 \text{ A/s}$, $s_1 = -5000$, and $s_2 = -1250$, find the constant $A_1$ required in the solution for $i(t)$.

a) $-0.033$

b) $-0.067$

c) $-0.133$

d) $-0.267$

e) none of these
Answers:
1. d
2. a
3. b
4. d
5. c
6. c
7. a
8. b
9. b
10. c
11. d
12. b