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

Part I: 7 questions  
Part II: 7 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

\[ x(t) = x(\infty) + A_1e^{s_1(t-t_0)} + A_2e^{s_2(t-t_0)} \]
\[ x(t_0) = x(\infty) + A_1 + A_2 \]
\[ x'(t_0) = s_1A_1 + s_2A_2 \]

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

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

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

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

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

1. What are the properties of the characteristic roots for an overdamped $RLC$ circuit?

   a) both real and negative   
   b) both real and positive   
   c) complex conjugates with negative real part   
   d) complex conjugates with positive real part   
   e) none of these

2. The switch has been in its initial position a long time. At what time will $i(t)$ be essentially zero?

   a) 5 µs   
   b) 15 µs   
   c) 25 µs   
   d) 35 µs   
   e) none of these

3. If a series $RLC$ circuit is critically damped and then the resistor is replaced by one having a smaller resistance, the circuit becomes

   a) overdamped   
   b) critically damped   
   c) underdamped   
   d) not enough information given   
   e) none of these

4. The switch has been open for a long time. Find $v(\infty)$.

   a) 4 V   
   b) 6 V   
   c) 8 V   
   d) 10 V   
   e) none of these
5. Given that \( i(t) = -5 \, mA \) for \( t < 0 \), find \( v(0^+) \).

- 25 V
- 75 V
- 50 V
- 25 V
- none of these

6. Which of the following can represent the natural response for capacitor current?

- a) 2.5 kV/s
- b) −2.5 kV/s
- c) 5.0 kV/s
- d) −5.0 kV/s
- e) none of these

7. Given that \( i(0^-) = 5 \, mA \) and \( v(0^-) = 10 \, V \), find \( v'(0^+) \).

- a) 2.5 kV/s
- b) −2.5 kV/s
- c) 5.0 kV/s
- d) −5.0 kV/s
- e) none of these
Part II.

8. Find $i(t)$ for $t > 0$. Assume the switch has been closed for a long time.

a) $2.5e^{-2t\times10^6} mA$
b) $1 + 2.5e^{-2t\times10^6} mA$
c) $1 + 2.5e^{-4t\times10^5} mA$
d) $2.5(1 - e^{-4t\times10^5}) mA$
e) none of these
9. About when will $v(t)$ reach its final value?

a) 0.22 ms
b) 0.25 ms
c) 1.11 ms
d) 1.25 ms
e) none of these
10. Given that $i(0^-) = 2 \ mA$ and $v(0^-) = 4 \ V$, find $v'(0^+)$.

a) $-100 \ V/s$

b) $200 \ V/s$

c) $-400 \ V/s$

d) $800 \ V/s$

e) none of these
11. Given that \(i(0^-) = 5 \, mA\) and \(v(0^-) = 10 \, V\), find \(i'(0^+).\)

a) \(2 \, kA/s\)
b) \(-2 \, kA/s\)
c) \(4 \, kA/s\)
d) \(-4 \, kA/s\)
e) none of these
12. Given that \( i(0^-) = 250 \, mA \), \( v(0^-) = -20 \, V \) and \( i'(0^+) = 0 \), find the appropriate constants \((A_1, A_2 \text{ or } B_1, B_2 \text{ or } D_1, D_2)\) that are needed to solve for \( i(t) \) \( t > 0 \).

a) 250 mA, 187.5 mA
b) 250 mA, 150 mA
c) 150 mA, 187.5 mA
d) 150 mA, 150 mA
e) none of these
13. Given that $i(0^-) = 20 \text{ mA}$, $\nu(0^-) = 0.2 \text{ V}$ and $\nu'(0^+) = -3 \text{ kV/s}$, find the appropriate constants ($A_1$, $A_2$ or $B_1$, $B_2$ or $D_1$, $D_2$) that are needed to solve for $\nu(t)$ $t > 0$.

a) 0.633, −0.233
b) −0.433, 0.233
c) 0.433, −0.233
d) −0.633, 0.233
e) none of these
14. The following circuit is

a) overdamped
b) critically damped
c) underdamped
d) undamped
e) none of these
Answers:
1. a
2. d
3. c
4. a
5. b
6. d
7. a
8. b
9. d
10. c
11. a
12. a
13. c
14. b