Closed book/notes, calculators allowed up to level of TI89, HP48.

**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.

Place your UA picture ID card on the adjacent desk where it can be easily seen.

When the 9:30 bell rings, begin the examination. 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 or before 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.

What are the properties of the roots of the characteristic equation for an underdamped RLC circuit?

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

A 100 μF capacitor is charged to 50 V. It is then discharged through a 1 MΩ resistor. How long will it take before it is essentially discharged?
a) 10 ms
b) 100 s
c) 500 s
d) 2 ms
e) none of these

Given $v_i(t)$ and the ideal op amp circuit shown below, which figure best represents $v_o(t)$?

![Diagram of op amp circuit](image)

(a) ![Graph](image)  
(b) ![Graph](image)  
(c) ![Graph](image)  
(d) ![Graph](image)  
(e) None of these
Given a parallel RLC circuit that is critically damped, what happens to the damping if R is increased?
It becomes:

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

The switch has been closed for a long time before t = 0. Find v(\infty).

a) 1 V
b) 0 V
c) -1 V
d) 100 mV
e) none of these

Find \(i(0^+).\)

a) 3 mA
b) 5 mA
c) 0 mA
d) 1.25 mA
e) none of these
PART II.

Assuming zero initial conditions, find \( v_o(t) \) at \( t=3 \) ms.

![Diagram of a circuit with a step input and a capacitor connected in parallel with a resistor.](image)

a) 2.1 V  
b) 3.0 V  
c) 0.0 V  
d) 0.9 V  
e) none of these
Assuming zero initial conditions, find $v_o(t)$ at $t=23$ ms.

a) 2.1 V  
b) 3.0 V  
c) 0.0 V  
d) 0.9 V  
e) none of these
The switch has been closed for a long time before \( t=0 \). Given \( v'(0)=16 \) v/s, find \( v(t) \).

a) \( v(t) = 24 - 21.33e^{-t} + 1.33e^{-4t} \) V
b) \( v(t) = 24 - 30e^{-t} + 10e^{-4t} \) V
c) \( v(t) = 24 + 1.33e^{-t} - 21.33e^{-4t} \) V
d) \( v(t) = 24 + 10e^{-4t} - 30e^{-t} \) V
e) none of these
The switch has been closed a long time before \( t = 0 \). Find \( i(t) \) for \( t > 0 \).

a) \( 4 - 8e^{-5t} \) A  
b) \( 4 + 8e^{-5t} \) A  
c) \( 2 + 4e^{-30t} \) A  
d) \( 2 + 4e^{-20t} \) A  
e) none of these
Assume zero initial conditions. Find \( i'(0^+) \).

a) 12 A/s  

b) 12 kA/s  

c) 2.4 mA/s  

d) 0 A/s  

e) none of these
The switch has been open for a long time before \( t = 0 \). Find \( i'(0^+) \).

a) 10 mA/s  
b) -10 mA/s  
c) 25 mA/s  
d) 5 mA/s  
e) none of these
Answers:
Part 1
1. D
2. C
3. D
4. B
5. A
6. A
Part II
1. A
2. D
3. A
4. C
5. B
6. C