

University of Arizona  
Department of Electrical & Computer Engineering

ECE 220      Basic Circuits

# Examination 4

April 20, 1999

Closed book/notes, calculators allowed.

**Part I – 8 questions    Part II – 8 questions.**

**Part II will be weighted by a factor of two relative to Part I.**

**IMPORTANT:** In the leftmost two columns (K, L) of the “special codes” block on the SCANTRON answer sheet, enter 11 if this page is ivory and 12 if it is green.

Please mark your **name and your ECE 220 ID number** on the SCANTRON answer sheet, using a #2 pencil. All information should be left justified. Also write the information below, and place your UA picture ID card on the adjacent desk where it can be easily seen.

When the 9:00 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.

e.g. 1     $\overset{\text{A}}{\textcircled{1}}$      $\overset{\text{B}}{\textcircled{2}}$      $\overset{\text{C}}{\bullet}$      $\overset{\text{D}}{\textcircled{4}}$      $\overset{\text{E}}{\textcircled{5}}$     if the answer for Question 1 is C.

All answer sheets and examinations will be collected at or before 9:55. 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: \_\_\_\_\_

Neper frequency for RLC ckts

$$\text{PARALLEL RLC: } \alpha = \frac{1}{2RC}$$

$$\text{SERIES RLC: } \alpha = \frac{R}{2L}$$

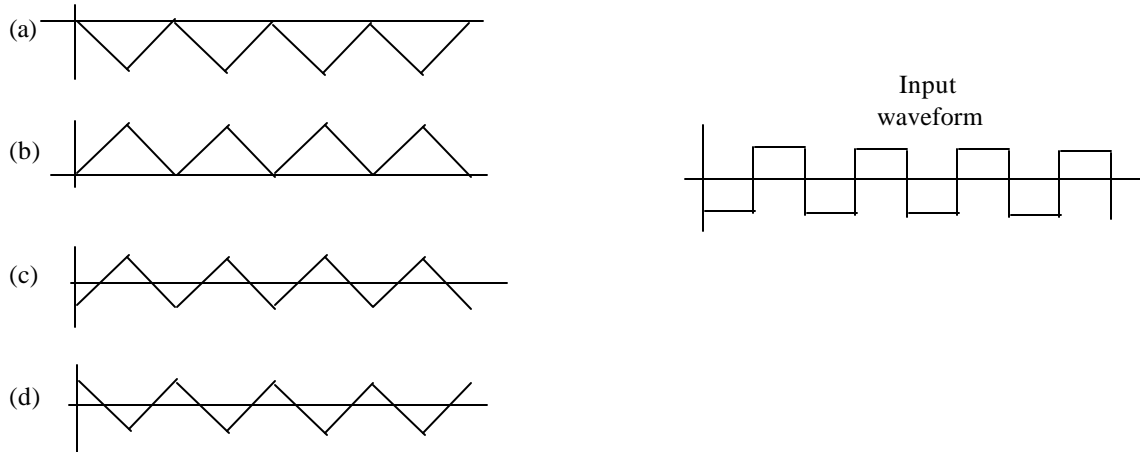
**Write your ECE 220 ID  
Number here and on the  
SCANTRON:**

**Part I 10 min**

[1] The roots of the characteristic equation for an RLC circuit depend on:

- (a) Component (R, L, C) values only.
- (b) Component values and initial conditions.
- (c) Same as (b) plus value of input voltage (or input current) applied to the circuit.
- (d) None of the above are completely correct.

[2] If a squarewave input voltage waveform (shown below right) is applied to an ideal op-amp integrating circuit, before saturation occurs, what will be shape of the waveform at the output of the amplifier ckt?



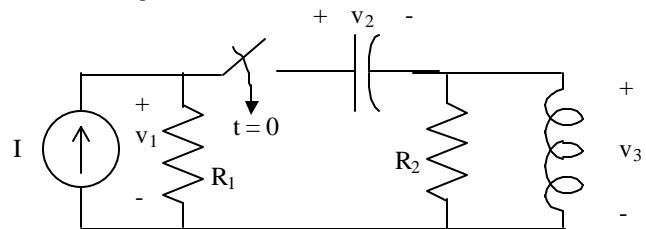
(e) None of these.

[3] What are the properties of the roots of the characteristic equation for an overdamped RLC ckt?

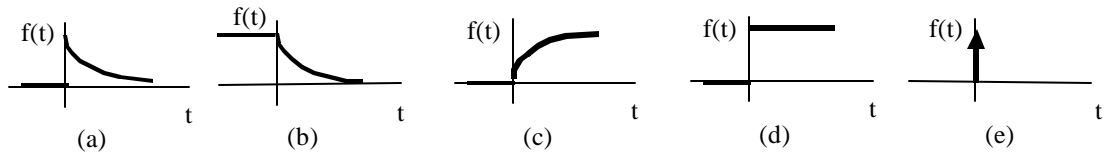
- (a) Complex with negative real part
- (b) Negative or positive, but real
- (c) Negative and real
- (d) Complex with negative or positive real part
- (e) None of these.

[4] What are the values of  $v_1$ ,  $v_2$ , and  $v_3$  at  $t = \infty$  in the following circuit?

- (a)  $v_1 = 0, v_2 = 0, v_3 = IR_1$
- (b)  $v_1 = 0, v_2 = IR_1, v_3 = 0$
- (c)  $v_1 = IR_1, v_2 = 0, v_3 = IR_1$
- (d)  $v_1 = IR_1, v_2 = IR_1, v_3 = 0$
- (e) None of these.



[5] Which of the following waveforms can represent the natural response for an inductor current?



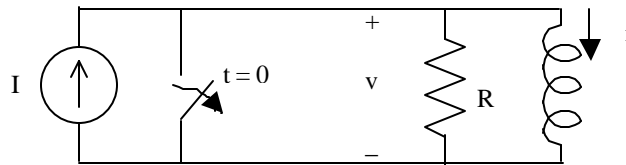
[6] Which statement is **false**?

In RLC circuits in steady state...

- (a) ... the capacitor acts as an open circuit.
- (b) ... the inductor acts as a short circuit.
- (c) ... the current through the inductor is always zero.
- (d) ... the voltage across the capacitor is always constant.
- (e) All are true.

[7] The switch has been closed for a long time, then it is opened at  $t = 0$ .  
Which conditions are true at the instant  $t = 0^+$  ?

- (a)  $v = 0, i = 0$
- (b)  $v = 0, i = I$
- (c)  $v = IR, i = 0$
- (d)  $v = IR, i = I$
- (e) None are true.



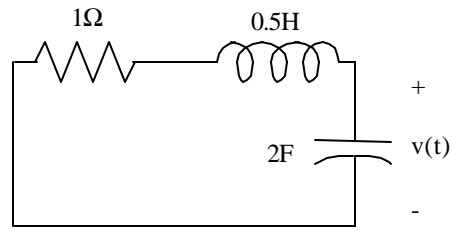
[8] A  $10 \mu\text{F}$  capacitor, initially charged to a constant voltage, is allowed to discharge through a  $50 \text{ k}\Omega$  resistor.  
For all practical purposes, how long does it take for the capacitor voltage to drop to a negligible fraction of its original value?

- (a) 2.5s
- (b) 1.25s
- (c) 1.0s
- (d) 0.5s
- (e) None of these.

**Part II 40 min**

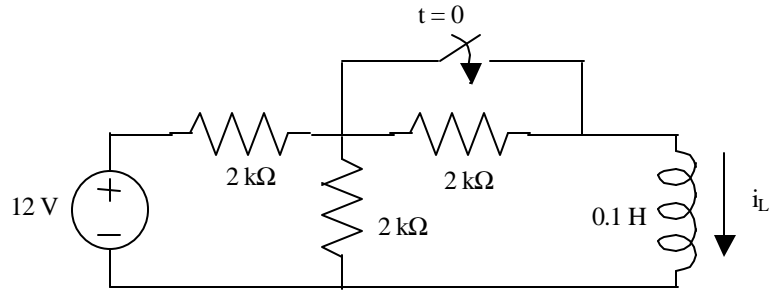
[9] The natural response of this circuit is of the form:

- (a)  $v(t) = Ae^{-t} + Be^{-t}$
- (b)  $v(t) = Ae^{-t} + Be^{-2t}$
- (c)  $v(t) = e^{-t}(A \cos t + B \sin t)$
- (d)  $v(t) = Ae^{-t} + Bte^{-t}$
- (e) None of these.



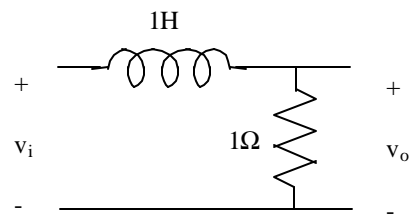
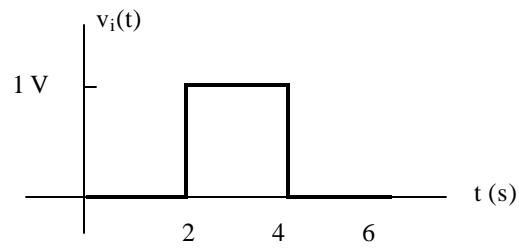
[ 10] The switch has been open for a long time and is closed at  $t = 0$ . What is the expression for  $i_L(t)$  for  $t > 0$ ?

- (a)  $6 - 6e^{-10^4 t}$  mA
- (b)  $8 - 6e^{-10^4 t}$  mA
- (c)  $6 - 4e^{-10^4 t}$  mA
- (d)  $6 - 2e^{-2 \times 10^4 t}$  mA
- (e) None of these.



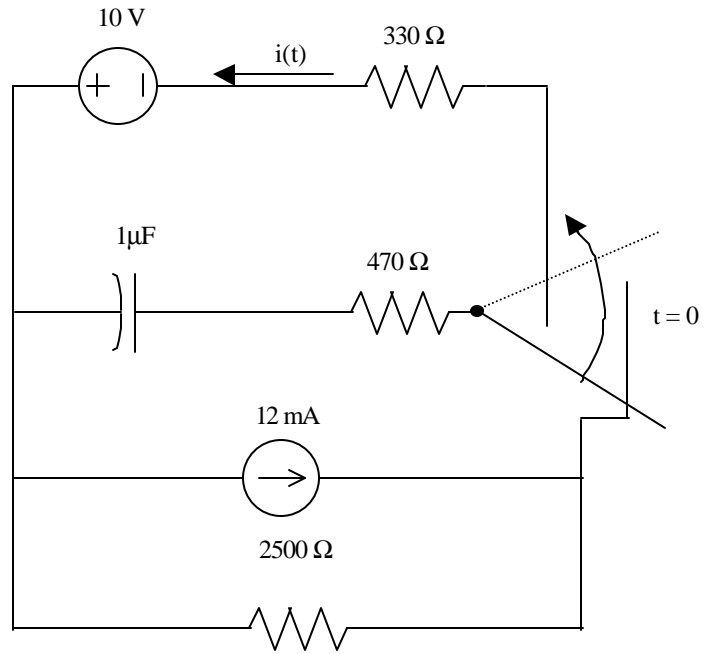
[11] Assuming the circuit contains zero energy at  $t = 0$ , find  $v_o$  at  $t = 6\text{s}$ .

- (a) 117mV
- (b) 123mV
- (c) 250mV
- (d) 560mV
- (e) None of these.



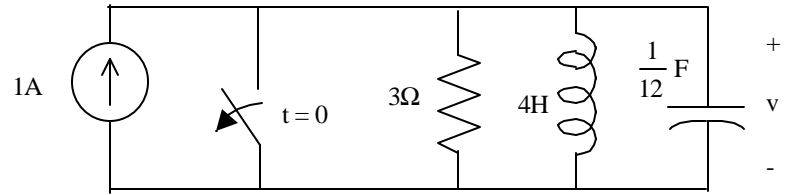
[12] Find  $i(t)$  for  $t > 0$ .

- (a)  $100e^{-625t}$  mA
- (b)  $50 + 35e^{-1250t}$  mA
- (c)  $50e^{-2500t}$  mA
- (d)  $50e^{-1250t}$  mA
- (e) None of these.



[13] Find  $v(t)$  for  $t > 0$ . (Assume the circuit contains no stored energy prior to the switch opening.)

- (a)  $-9 + 9e^{-t} - 9te^{-t}$  V
- (b)  $-12 + 6e^{-t} + 6e^{-3t}$  V
- (c)  $-3 + 6e^{-t} - 6e^{-3t}$  V
- (d)  $6e^{-t} - 6e^{-3t}$  V
- (e) None of these.



[14] Which characteristic equation represents a critically damped parallel RLC ckt?

(a)  $s^2 + 4s + 3 = 0$

(b)  $s^2 + s + 0.25 = 0$

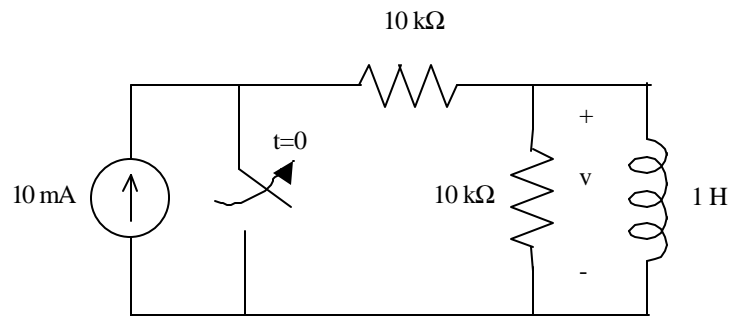
(c)  $s^2 + 2s + 2 = 0$

(d)  $s^2 + s - 2 = 0$

(e) None of these.

[ 15] The switch shown has been closed for a long time. It is opened at  $t = 0$ .  
Find  $v(0^-)$ ,  $v(0^+)$  and  $v(\infty)$ .

- (a)  $v(0^-) = 0$ ,  $v(0^+) = 100\text{V}$ ,  $v(\infty) = 0$
- (b)  $v(0^-) = 0$ ,  $v(0^+) = 0$ ,  $v(\infty) = 0$
- (c)  $v(0^-) = 0$ ,  $v(0^+) = \infty$ ,  $v(\infty) = 0$
- (d)  $v(0^-) = 0$ ,  $v(0^+) = 100\text{V}$ ,  $v(\infty) = 100\text{V}$
- (e) None of these.



[ 16] The capacitor is initially charged to 20V before the switch is closed. How long does it take for the current  $i$  to reach its maximum value?

- (a) 0
- (b)  $49.67\mu\text{s}$
- (c)  $99.44\mu\text{s}$
- (d)  $198.7\mu\text{s}$
- (e) None of these.

