ECE 20100 – Spring 2017
Exam #2

March 9, 2017

Section (include on scantron)

Qi (12:30) – 0001 Tan (10:30) – 0004 Hosseini (7:30) – 0005

Cui (1:30) – 0006 Jung (11:30) – 0007

Lin (9:30) – 0008 Peleato-Inarrea (2:30) – 0009

Instructions

1. DO NOT START UNTIL TOLD TO DO SO.
2. Write your name, section, professor, and student ID# on your **Scantron** sheet. We may check PUIDs.
3. This is a CLOSED BOOKS and CLOSED NOTES exam.
4. The use of a TI-30X IIS calculator is allowed.
5. If extra paper is needed, use the back of test pages.
6. Cheating will not be tolerated. Cheating in this exam will result in, at the minimum, an F grade for the course. In particular, **continuing to write after the exam time is up is regarded as cheating**.
7. If you cannot solve a question, be sure to look at the other ones, and come back to it if time permits.
8. ***All of the problems*** on Exam #2 provide evidence for satisfaction of this ECE 20100 Learning Objective:

   ii) An ability to analyze first-order linear circuits.

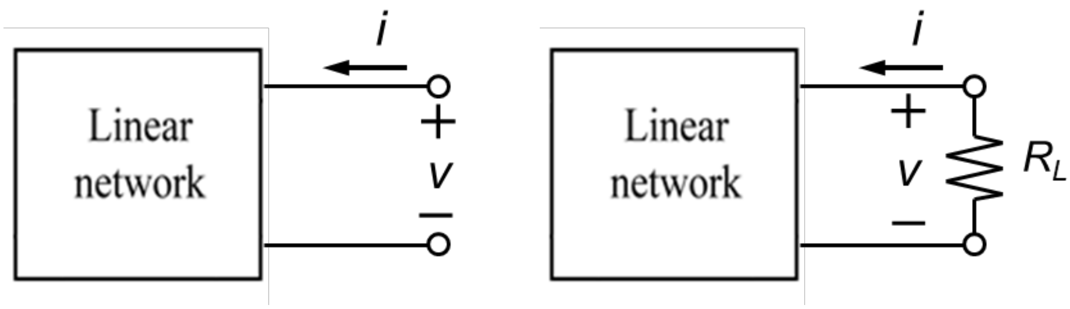
   The minimum score needed to satisfy this objective will be posted on Blackboard after the exam has been graded. Remediation options will be posted in Blackboard if you fail to satisfy any of the course outcomes.

By signing the scantron sheet, you affirm you have not received or provided assistance on this exam.

Question 1

A linear circuit, represented by the illustration on the left, contains only resistors, dependent sources *and independent sources*. The current-voltage relationship for this circuit is known to be:

$$i = v - 8$$



If a variable load resistor is attached to the circuit as shown in the illustration on right, find the maximum power transferred to the load resistor (in W).

(1) 2

(2) 4

(3) 6

(4) 8

(5) 10

(6) 12

(7) 14

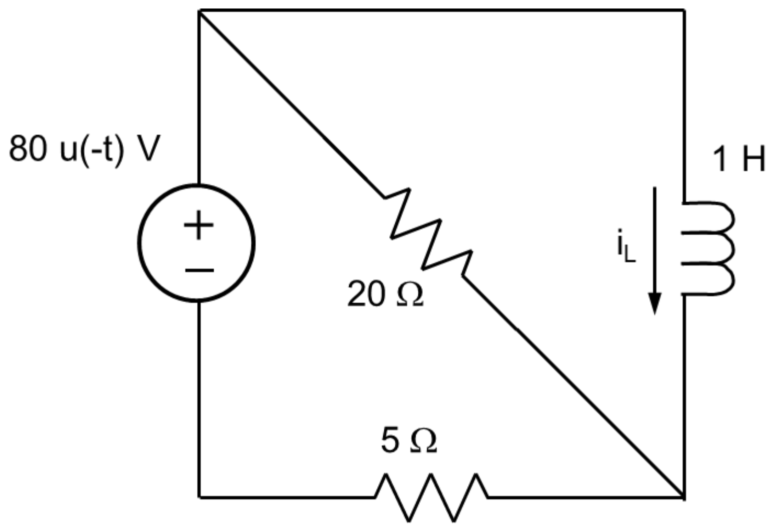
(8) 16

(9) 18

(10) None of the above

Question 2

In the circuit below, find the current through the inductor (in A) for $t \geq 0$ sec.



(1) $16\, e^{-5t}$

(2) $16\, e^{-2t}$

(3) $16\, e^{-t}$

(4) $16\, e^{-4t}$

(5) $4\, e^{-5t}$

(6) $4\, e^{-2t}$

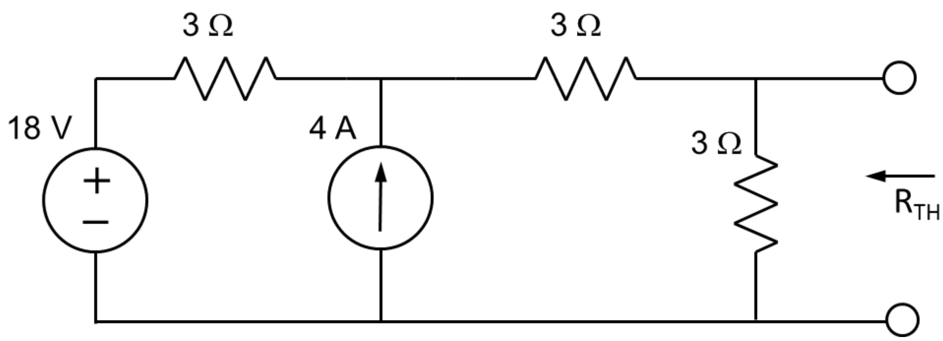
(7) $4\, e^{-t}$

(8) $4\, e^{-4t}$

(9) None of the above

Question 3

In the circuit shown below, find the Thevenin equivalent resistance (in Ω).



(1) 1.8

(2) 2.0

(3) 2.2

(4) 2.4

(5) 2.6

(6) 2.8

(7) 3.0

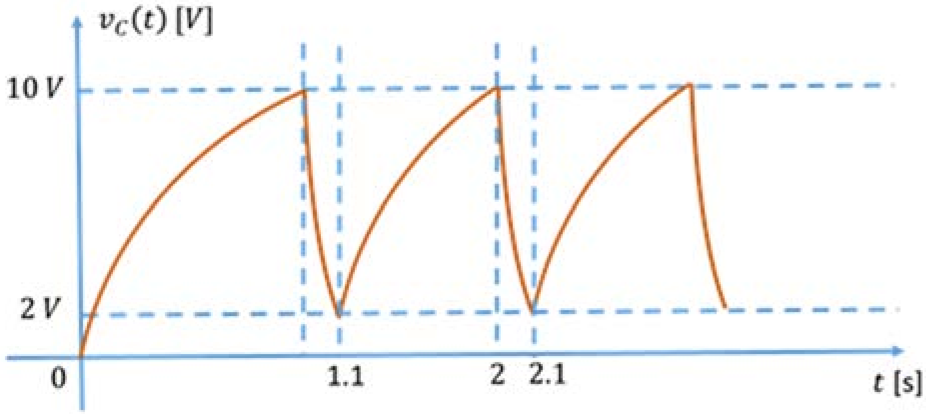
(8) 3.2

(9) 3.6

(10) None of the above

Question 4

The following graph presents an approximate saw-tooth voltage measured across a capacitor that has been generated by a 1st order RC circuit during successive charging and discharging cycles. Find the closest value for the ratio of the time constant for the charging cycle divided by the time constant for the discharging cycle. Assume the final capacitor voltage for the charging cycle is 11 V, and the final capacitor voltage for the discharging cycle is 0 V.



(1) 0.11

(2) 0.25

(3) 0.33

(4) 4.62

(5) 5

(6) 5.56

(7) 6.59

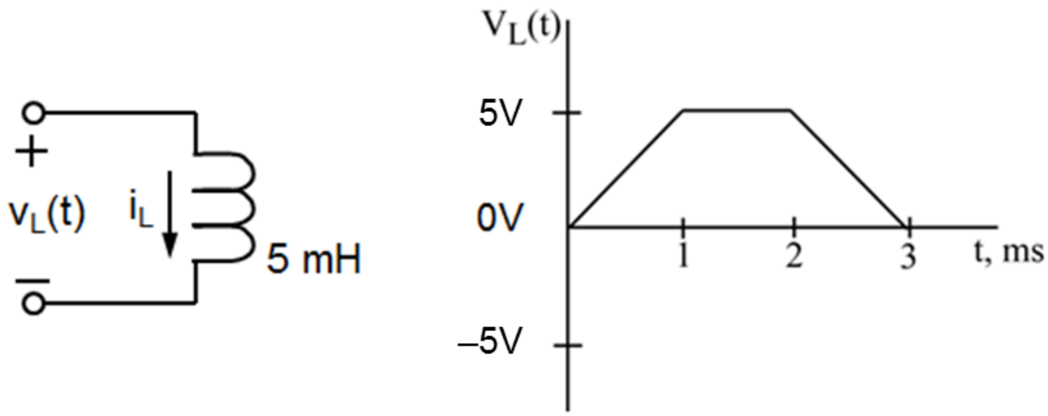
(8) 7.50

(9) 9

(10) None of the above

Question 5

The voltage across the inductor shown below is given in the plot. The current i_L at $t = 0$ is $i_L(0) = -1$ A. Determine the current i_L at $t = 3$ ms (in A).



(1) 1

(2) 2

(3) 3

(4) 4

(5) 5

(6) 6

(7) 7

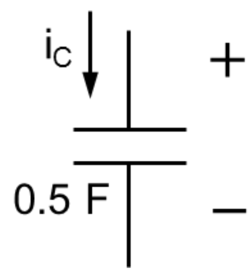
(8) 8

(9) 9

(10) None of the above

Question 6

A 0.5 F capacitor shown below has a current of 4 cos(t) A passing through it. Find the instantaneous stored energy in the capacitor at t = $\pi/2$ s (in Joules) assuming the capacitor has zero initial voltage at t = 0 sec.



(1) 12

(2) 16

(3) 32

(4) 4

(5) 48

(6) 36

(7) 64

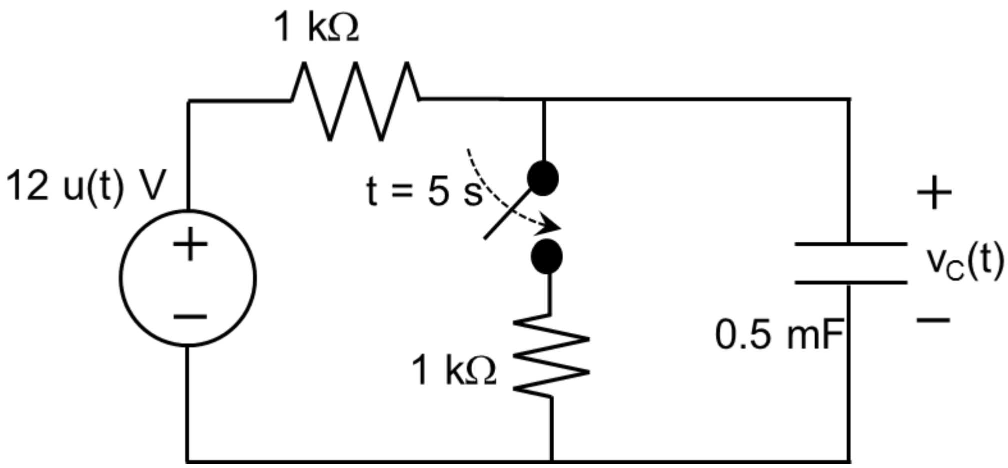
(8) 8

(9) 18

(10) None of the above

Question 7

In the circuit shown, the capacitor voltage at t = 0 sec is 0 V. The switch shown in the figure is initially open (as shown), and closes at t = 5 sec. Find the closest value for the capacitor voltage $V_C(t)$ at t = 5.4 sec (in V).



(1) 4.66

(2) 5.29

(3) 6.47

(4) 6.83

(5) 7.21

(6) 7.62

(7) 8.43

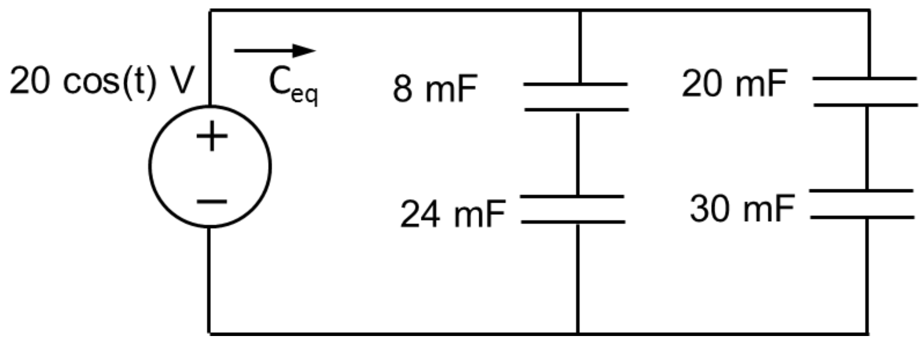
(8) 9.17

(9) 9.65

(10) None of the above

Question 8

In the circuit shown below, find the equivalent capacitance seen by the voltage source (in mF).



(1) 10

(2) 2

(3) 30

(4) 14

(5) 12

(6) 27

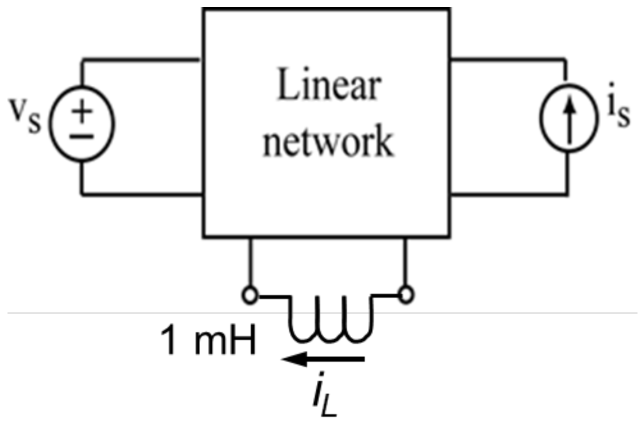
(7) 16

(8) 18

(9) None of the above

Question 9

In the circuit shown below, the inductor current is dependent on the voltage source, current source, and initial conditions according to the relations listed below. If the initial current is doubled, the voltage source is doubled, and the current source is cut in half, find the total response after all three changes have been implemented (in A).



Zero-state voltage source response: $(3 - 3e^{-2t})$ A

Zero-state current source response: $(4 - 4e^{-2t})$ A

Zero-input response: $2e^{-2t}$ A

(1) $1 + 5\,e^{-2t}$

(2) $2 - 2\,e^{-2t}$

(3) $3 + 2\,e^{-2t}$

(4) $8 - 4\,e^{-2t}$

(5) $3 - 3\,e^{-2t}$

(6) $6 - 3\,e^{-2t}$

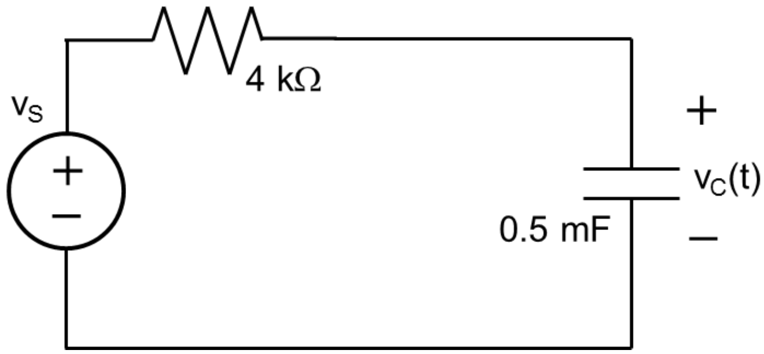
(7) $6 + 5\,e^{-2t}$

(8) $8 + 8\,e^{-2t}$

(9) None of the above

Question 10

In the circuit below, $v_S = 5\ u(-t) + 9\ u(t)$ V. Find the capacitor voltage for $t \geq 0$ sec (in V).



(1) $5 + 9e^{-t/2}$

(2) $4 - 5e^{-t/2}$

(3) $5 + 5e^{-t/2}$

(4) $9 - 4e^{-t/2}$

(5) $5 - 5e^{-t/2}$

(6) $4 - 9e^{-t/2}$

(7) $9 + 9e^{-t/2}$

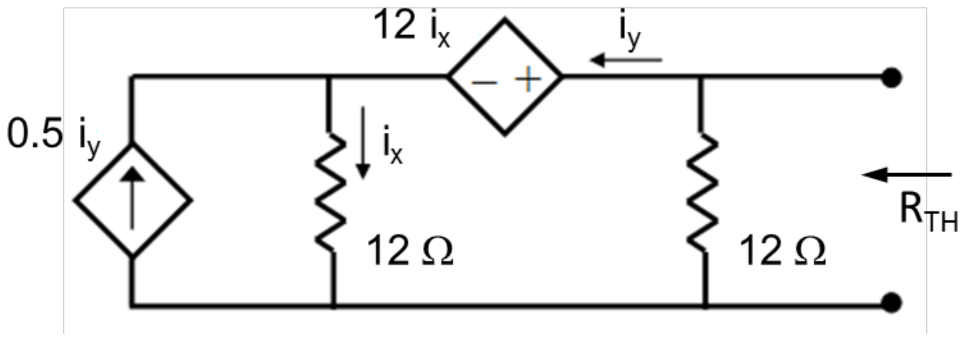
(8) $4 - 4e^{-t/2}$

(9) $9 - 9e^{-t/2}$

(10) None of the above

Question 11

In the circuit below, find the Thevenin resistance, R_{TH} (in Ω).



(1) 1

(2) 2

(3) 3

(4) 4

(5) 5

(6) 6

(7) 7

(8) 8

(9) 9

(10) None of the above

Potentially Useful Formulas

$$x(t) = x(\infty) + \left[x(t_0^+) - x(\infty) \right] e^{-(t-t_0)/\tau}$$, where $\tau = R_{TH}C$ or $\tau = \dfrac{L}{R_{TH}}$

$$v_L(t) = L\frac{di_L(t)}{dt} \qquad i_C(t) = C\frac{dv_C(t)}{dt}$$

$$i_L(t) = i_L(t_0) + \frac{1}{L}\int_{t_0}^{t} v_L(t')dt' \qquad v_C(t) = v_C(t_0) + \frac{1}{C}\int_{t_0}^{t} i_C(t')dt'$$

$$W_L(t_0,t_1) = \frac{L}{2}\left[\left(i_L(t_1)\right)^2 - \left(i_L(t_0)\right)^2 \right] \qquad W_C(t_0,t_1) = \frac{C}{2}\left[\left(v_C(t_1)\right)^2 - \left(v_C(t_0)\right)^2 \right]$$

Elapsed time formula: $t_2 - t_1 = \tau \ln \dfrac{x(t_1) - x(\infty)}{x(t_2) - x(\infty)}$

$$-\ln x = \ln\frac{1}{x}$$

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Solution Key:

1. (8)
2. (4)
3. (2)
4. (7)
5. (1)
6. (2)
7. (5)
8. (8)
9. (4)
10. (4)
11. (9)