# ECE 20100 – Fall 2015
# Exam #2

## October 20, 2015

## Section (circle below)

Cui (3:30) – 0002 Chen (11:30) – 0004 Tan (1:30) – 0005

Zhu (2:30) – 0011 Peleato-Inarrea (10:30) – 0012

Name ____________________________ PUID____________

***Instructions***

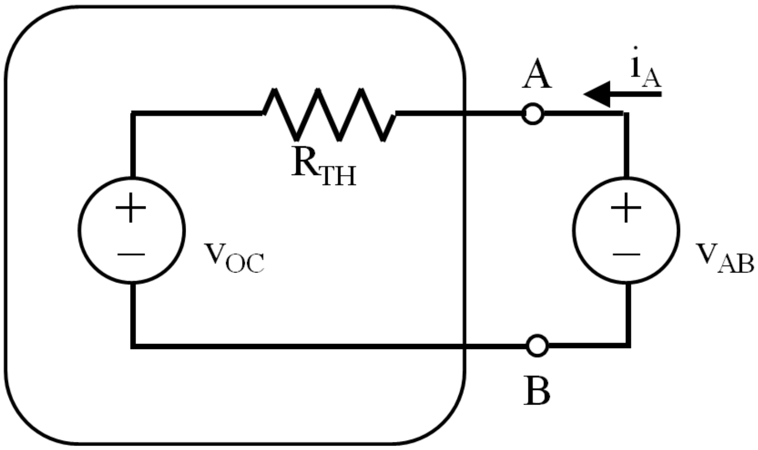
1. DO NOT START UNTIL TOLD TO DO SO.
2. Write your name, section, professor, and student ID# on your **Scantron** sheet. We may check PUIDs.
3. This is a CLOSED BOOKS and CLOSED NOTES exam.
4. The use of a TI-30X IIS calculator is allowed, but not necessary.
5. If extra paper is needed, use the back 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 linear resistive 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.

**Question 1**

The figure below shows the Thevenin equivalent of an unknown resistive network with fixed independent sources, attached to a variable voltage source $v_{AB}$. Two measurements of $v_{AB}$ and $i_A$ are shown below. Find $v_{OC}$ and $R_{th}$ :




| $i_A$ (A) | $v_{AB}$ (V) |
|---|---|
| 2 | 200 |
| 4 | 300 |

(1) −200 V, 100 Ω

(2) −100 V, 100 Ω

(3) −100 V, 50 Ω

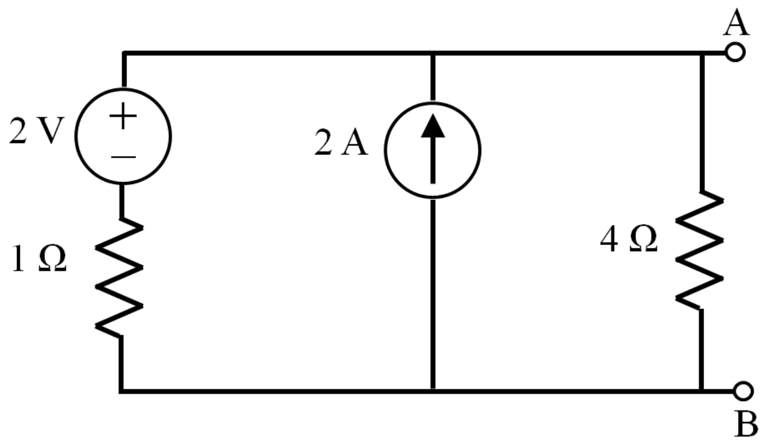
(4) 200 V, 100 Ω

(5) 100 V, 100 Ω

(6) 100 V, 50 Ω

**Question 2**

For the circuit in the figure below, find $R_{th}$ and $V_{oc}$ in the Thevenin equivalent circuit.




(1) 0.8 Ω and 3.2 V

(2) 5 Ω and 2 V

(3) 5 Ω and 4 V

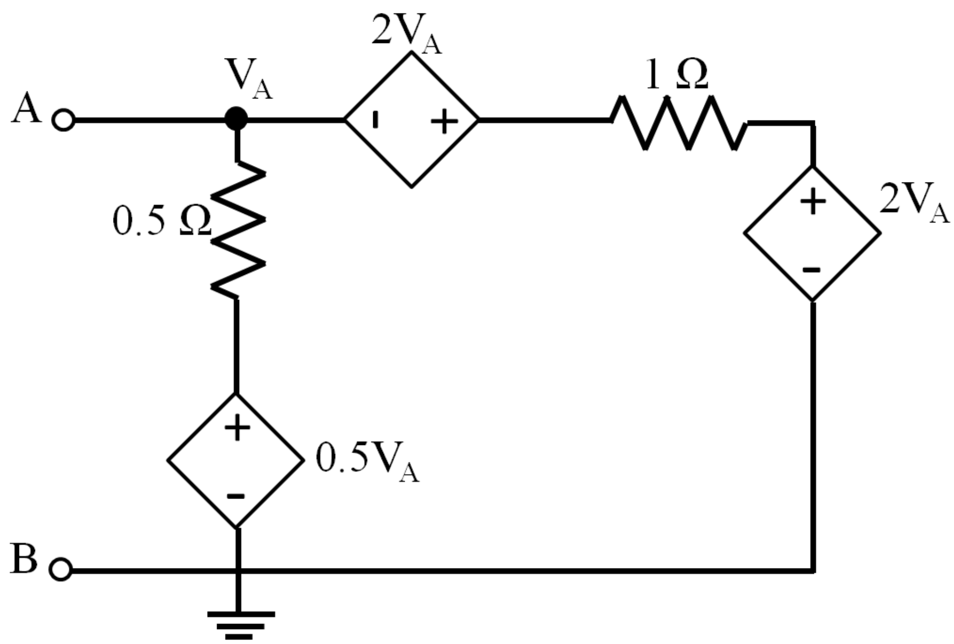
(4) 0.8 Ω and 2 V

(5) 0.8 Ω and 4 V

(6) 4 Ω and 2V

**Question 3**

For the circuit in the figure below, find $R_{th}$ .




(1) 1 Ω

(2) 2 Ω

(3) 1.5 Ω

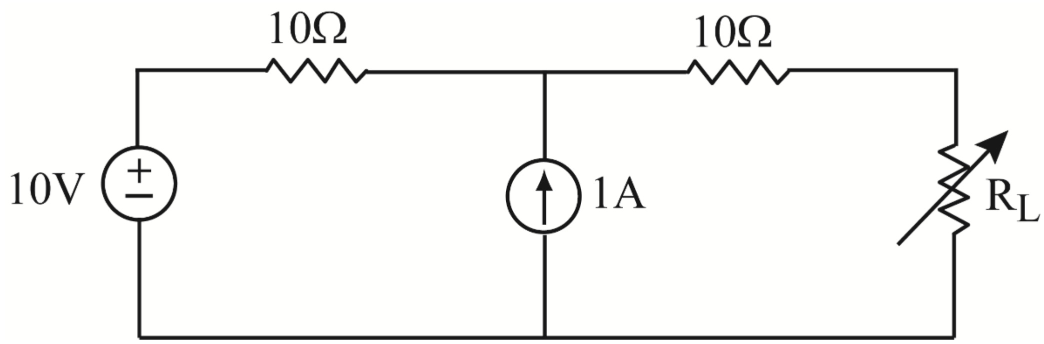
(4) 0.5 Ω

(5) 0.67 Ω

(6) 2.5 Ω

**Question 4**

In the circuit shown below, $R_L$ is variable. Determine the maximum power delivered to $R_L$ in the circuit below.




(1) 1 W

(2) 2 W

(3) 3 W

(4) 4 W

(5) 5 W

(6) 6 W

(7) 7 W

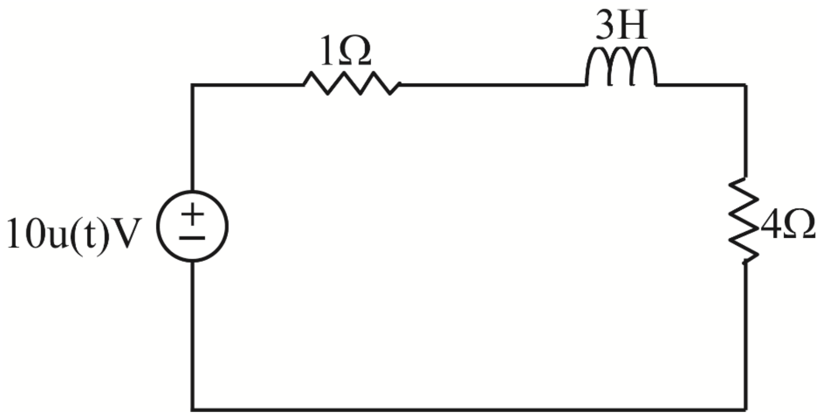
(8) 8 W

(9) 9 W

(10) 10 W

**Question 5**

The RL circuit is driven by a constant voltage source as shown below. Calculate the energy stored in the inductor at $t = \infty$.




(1) 1 J

(2) 2 J

(3) 3 J

(4) 4 J

(5) 5 J

(6) 6 J

(7) 7 J

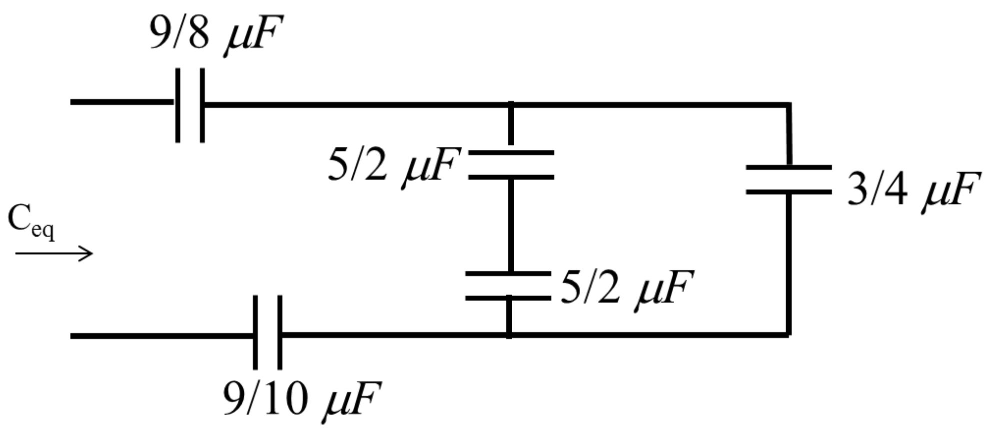
(8) 8 J

(9) 9 J

(10) 10 J

**Question 6**

Find the equivalent capacitance $C_{eq}$:




(1) 31/4 μF

(2) 2463/920 μF

(3) 4/5 μF

(4) 2/5 μF

(5) 5/2 μF

(6) 5/4 μF

(7) 1 μF

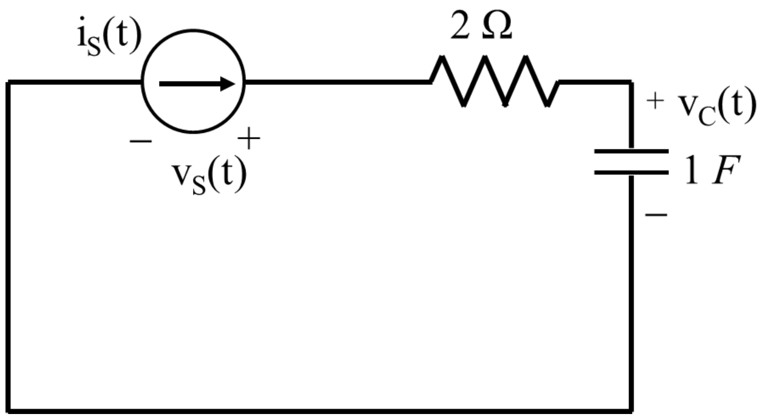
(8) 4 μF

(9) 920/2463 μF

(10) None of above

### Question 7

If $i_S(t) = e^{-t}$ A, and $v_C(0) = 1$V. Find the voltage $v_s(t)$ across the source for $t > 0$:




(1) 1 V

(2) $1 + e^{-t}$ V

(3) $1 - e^{-t}$ V

(4) 2V

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

(6) $2 - e^{-t}$ V

(7) 3V

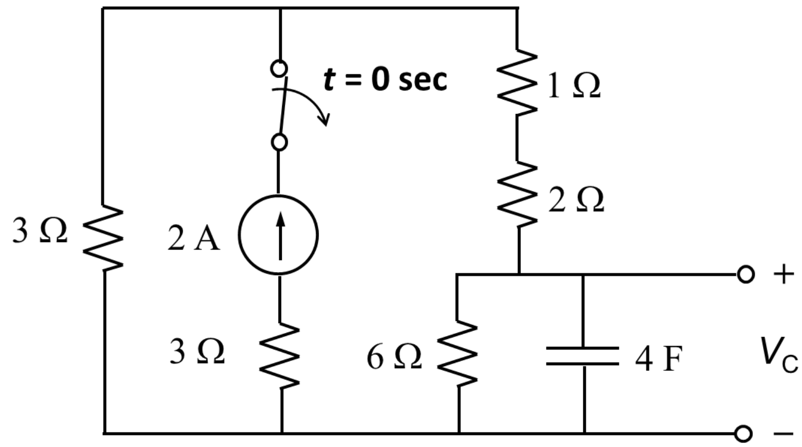
(8) $2e^{-t}$ V

(9) $6 - 3e^{-t}$ V

(10) None of the above.

**Question 8**

The switch in the figure below has been closed for a long time. At $t$ = 0, the switch opens. Determine $V_C(t)$ for t > 0.




(1) $V_C = 12e^{-\frac{t}{24}}$ V

(2) $V_C = 6e^{-\frac{t}{24}}$ V

(3) $V_C = 3e^{-\frac{t}{24}}$ V

(4) $V_C = 2e^{-\frac{t}{24}}$ V

(5) $V_C = e^{-\frac{t}{24}}$ V

(6) $V_C = 12e^{-\frac{t}{12}}$ V

(7) $V_C = 6e^{-\frac{t}{12}}$ V

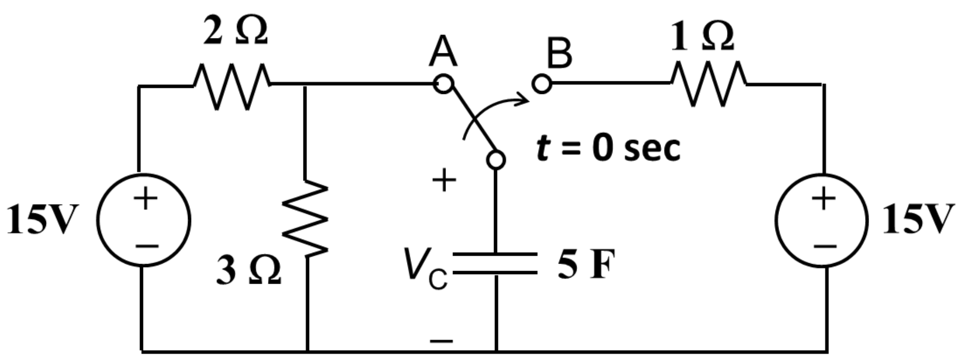
(8) $V_C = 3e^{-\frac{t}{12}}$ V

(9) $V_C = 2e^{-\frac{t}{12}}$ V

(10) $V_C = e^{-\frac{t}{12}}$ V

**Question 9**

The switch in the circuit below has been in position A for a long time. At $t$ = 0, the switch moves to B. Determine $V_C(t)$ for t > 0.




(1) $V_C = 15 - 6e^{-\frac{t}{5}}$ V

(2) $V_C = 6 + 9e^{-\frac{t}{5}}$ V

(3) $V_C = 9 + 6e^{-\frac{t}{5}}$ V

(4) $V_C = 6 - 15e^{-\frac{t}{5}}$ V

(5) $V_C = 15 - 9e^{-\frac{t}{5}}$ V

(6) $V_C = 15 - 6e^{-\frac{t}{6}}$ V

(7) $V_C = 6 + 9e^{-\frac{t}{6}}$ V

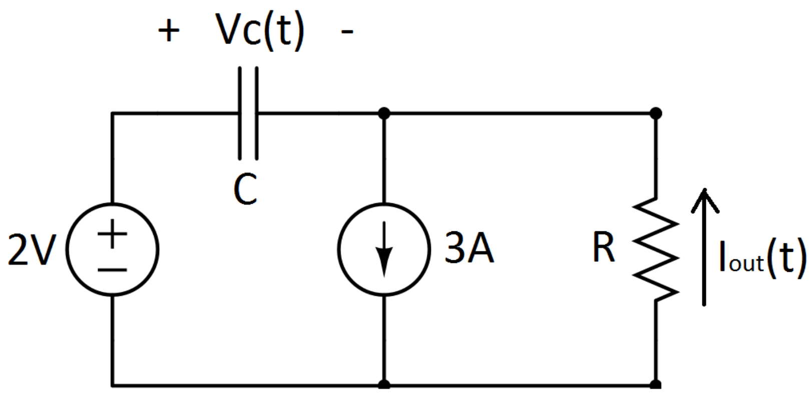
(8) $V_C = 9 + 6e^{-\frac{t}{6}}$ V

(9) $V_C = 6 - 15e^{-\frac{t}{6}}$ V

(10) $V_C = 15 - 9e^{-\frac{t}{6}}$ V

**Question 10**

You know that at time t = 0, the voltage at the capacitor $V_C(0) = 5V$. Which of the expressions below gives the zero-input response for $I_{out}(t)$ t>0?




(1) $I_{out}^{(z.i.)}(t) = 3$ Amp

(2) $I_{out}^{(z.i.)}(t) = -3$ Amp

(3) $I_{out}^{(z.i.)}(t) = 3/R$ Amp

(4) $I_{out}^{(z.i.)}(t) = -3/R$ Amp

(5) $I_{out}^{(z.i.)}(t) = 2/RC$ Amp

(6) $I_{out}^{(z.i.)}(t) = -2/RC$ Amp

(7) $I_{out}^{(z.i.)}(t) = 5/R*\exp(-t/RC)$ Amp

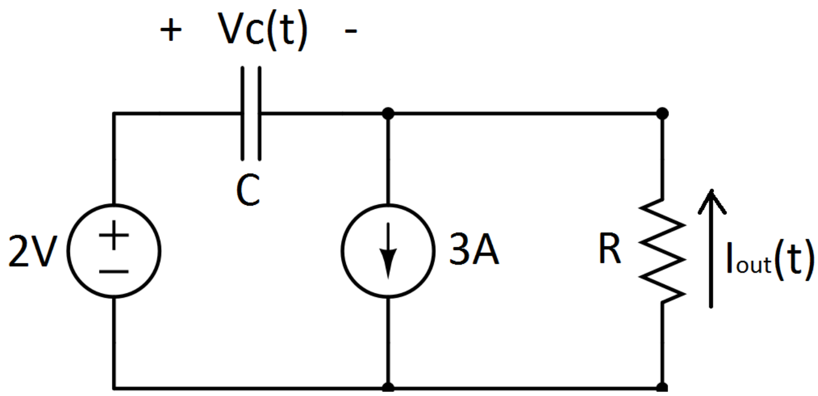
(8) $I_{out}^{(z.i.)}(t) = -5/R*\exp(-t/RC)$ Amp

(9) $I_{out}^{(z.i.)}(t) = 3R*\exp(-t/RC)$ Amp

(10) $I_{out}^{(z.i.)}(t) = -3R*\exp(-t/RC)$ Amp

**Question 11**

You know that at time t = 0, the voltage at the capacitor $V_C(0) = 5V$. Also, you have measured that, at t = RC, $V_C(RC) = 3 + 2*e^{-1}$. What would $V_C(RC)$ be if the value of the voltage source doubled to 4V with the same initial conditions ($V_C(0) = 5V$)?




(1) $V_C\,(RC) = 0$ V

(2) $V_C\,(RC) = 5$ V

(3) $V_C\,(RC) = 8$ V

(4) $V_C\,(RC) = 3 + 5*e^{-1}$ V

(5) $V_C\,(RC) = 6 + 6*e^{-1}$ V

(6) $V_C\,(RC) = 8 + 3*e^{-1}$ V

(7) $V_C\,(RC) = 3 + (5 - 2RC)*e^{-1}$ V

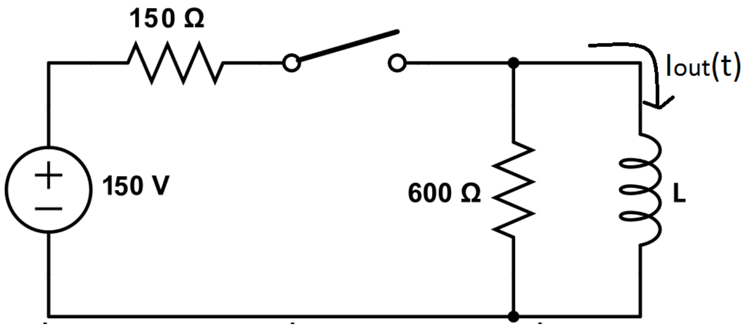
(8) $V_C\,(RC) = 6 + (6 - 2RC)*e^{-1}$ V

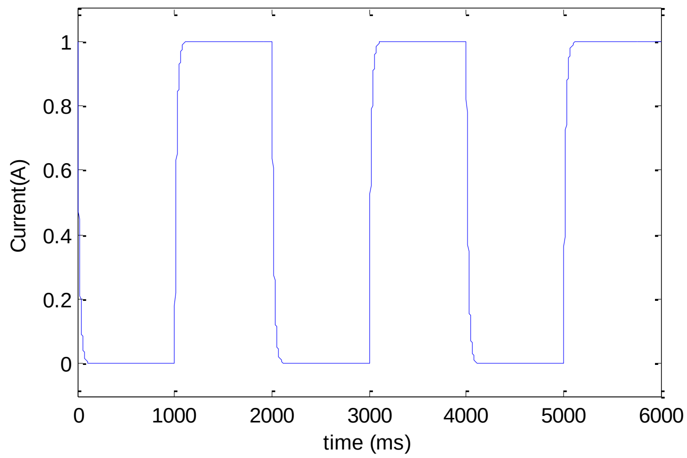
(9) $V_C\,(RC) = 8 + (3 - 2RC)*e^{-1}$ V

(10) None of the above

**Question 12**

The switch in the circuit below changes its position every second, generating the square current shown in the figure. We want **BOTH** transitions from current = 0 to current = $1\text{-}e^{-3}$ **AND** from current = 1 to current = $e^{-3}$ to take less than 1ms **EACH**. What is the largest inductance that we can use?




(1) L = 1 mH

(2) L = 8 mH

(3) L = 20 mH

(4) L = 32 mH

(5) L = 40 mH

(6) L = 70 mH

(7) L = 200 mH

(8) L = 500 mH

(9) L = 1 H

(10) We can use an inductor larger than all the above ones

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**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 $\tau = \dfrac{L}{R_{TH}}$

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

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

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

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

Elapsed time formula: $t_2 - t_1 = \tau \ln[(X_1 - x(\infty))/(X_2 - x(\infty))]$