ECE 20100 – Spring 2017
Exam #1
February 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, 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 #1 provide evidence for satisfaction of this ECE 20100 Learning Objective:
   i) 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.

By signing the scantron sheet, you affirm you have not received or provided assistance on this exam.
Question 1

The voltage drop across a 20 ohm resistor varies with time according to the following:

\[ v(t) = 0 \text{ V for } t < 0; \ v(t) = 60 + 40t \text{ V for } t \geq 0 \]

where time (t) is measured in seconds. What is the quantity of charge that passes through the resistor between 1 and 3 sec (in Coulombs):

(1) 4
(2) 6
(3) 8
(4) 10
(5) 12
(6) 14
(7) 16
(8) 18
(9) None of the above

First, plot the \( v \) vs \( t \):

\[
\begin{align*}
\Delta Q &= \int_{1}^{3} i(t) \, dt \\
&= \frac{1}{R} \int_{1}^{3} v(t) \, dt \\
&= \frac{1}{20} \int_{1}^{3} (60 + 40t) \, dt \\
&= \frac{1}{20} \left[ 60t \Big|_{1}^{3} + \frac{1}{2} (40t^2) \Big|_{1}^{3} \right] \\
&= \frac{1}{20} \left[ 60(3-1) + \frac{1}{2} (40)(3^2-1^2) \right] \\
&= \frac{1}{20} \left[ 120 + 160 \right] \\
&= 14 \text{ Coul.}
\end{align*}
\]
Question 2

In the circuit below, find the equivalent resistance (in Ω) as seen by the current source.

(1) 12
(2) 2
(3) 3
(4) 8
(5) 16
(6) 24
(7) 32
(8) 36
(9) None of the above
Question 3

In the circuit shown below, find the current $I_x$.

1. $1 \text{ A}$
2. $2 \text{ A}$
3. $3 \text{ A}$
4. $4 \text{ A}$
5. $5 \text{ A}$
6. $6 \text{ A}$
7. $7 \text{ A}$
8. $8 \text{ A}$
9. None of the above

Step 1: Compact nodes

$I_{total} = \frac{80 \text{ V}}{12 \Omega + 4 \Omega} = 5 \text{ A}$

$I_x = \frac{30}{30 + 20} I_{total} = 5 \times \frac{30}{50} = 3 \text{ A}$
Question 4

Find the power delivered by the dependent source (in W).

\[
\text{Step 1: Voltage division}
\]

\[V_1 = 12 \times \frac{3}{6+3} = 4 \text{ V}\]

So \[I_1 = 2V_1 = 8 \text{ A}\]

\[V_S = I_1 \times (2) = 16 \text{ V}\]

So the power ABSORBED by the dependent current source is \((16)(-8) = -128 \text{ W}\)

The power delivered by the dependent source is \(-(-128) = 128 \text{ W}\)

(1) 256
(2) 128
(3) 64
(4) 32
(5) 16
(6) 8
(7) 4
(8) 2
(9) None of the above
Question 5

In the circuit shown below, find the nodal voltage $V_B$ (in V).

Using KCL @ nodes A, B, D, C sequentially, we can get the currents of every branch.

\[ I_1 = 6A \]  \Rightarrow  \[ 0.2I_1 = 1.2A \]
\[ 0.3I_1 = 1.8A \]

So \[ V_B - V_{BG} = V_{BD} + V_{DC} + V_{CG} \]
\[ = (3)I_{BD} + (5)I_{DC} + (1)I_{CG} \]
\[ = (3)(3) + (5)(6.2) + (1)(8) \]
\[ = 48 \text{ V} \]
Question 6

The circuit shown below is the same as in Question 5, except the ground node has been changed. Find the nodal voltage $V_B$ (in V).

\[ I_1 = 6 \text{A} \Rightarrow \begin{cases} 0.2 I_1 = 1.2 \text{A} \\ 0.3 I_1 = 1.8 \text{A} \end{cases} \]

Apply KCL @ node B

\[ I_{BD} + 1.2 + 1.8 = 6 \Rightarrow I_{BD} = 3 \text{A} \]

So \[ V_{BD} = I_{BD} (3 \Omega) = 9 \text{V} \]

Since D is ground \[ V_D = 0 \]

\[ V_B = V_{BD} = V_B - V_D = 9 \text{V} \]

(1) 3
(2) 6
(3) 9
(4) 12
(5) 24
(6) 36
(7) 48
(8) 60
(9) None of the above
Question 7

In the circuit shown, rectangular shapes represent general circuit elements (either resistors or sources). Find the voltage $V_{MA}$ (in V).

\[
V_{MA} = V_{ML} + V_{LG} + V_{GF} - V_{FB} + V_{BA}
\]

\[
= (-9) + 4 + [(-5)] + [(-2)] + [-8]
\]

\[
= -6 \text{ V}
\]

(1) -3
(2) -6
(3) -9
(4) -12
(5) 3
(6) 6
(7) 9
(8) 12
(9) None of the above
Question 8

In the circuit shown below, find nodal voltage $V_A$ (in V).

Solution 1: Use current division

$I_1 = 6 \frac{6}{12+6} = 2\,\text{A}$

$V_A = V_{AG} = (I_1)(6\,\Omega)$

$= 24\,\text{V}$

Solution 2: Nodal analysis at node A:

$6 = \frac{V_A}{12} + \frac{V_A}{6}$

$V_A = 24\,\text{V}$

(1) 3
(2) 6
(3) 9
(4) 12
(5) 24
(6) 36
(7) 48
(8) 60
(9) None of the above
Question 9

In the circuit shown below, find the loop current $I_1$ (in A).

\[ I_2 = 1 \text{A} \]
\[ I_3 = 2 \text{A} \]

**KVL for Loop of $I_1$:**

\[ V_{AB} + V_{BG} = V_{AG} \]

\[ 3(I_2 + 1) + 1(I_1 + 2) = 9 \]

So $I_1 = 1 \text{A}$
Question 10

Find $v_o$ (in V) for the circuit shown.

Solution 1: Node analysis @ node A

$\sum \text{IN} = \sum \text{OUT}$

\[ \frac{27 - V_A}{6} + 6 = \frac{V_A}{2 + 1} \]

So $V_A = 21$ V

Use voltage division

$V_o = 21 \cdot \frac{1}{2 + 1} = 7$ V

Solution 2: Source transformation

$V_o = (1 \Omega)(7A) = 7$ V
Question 11

In the circuit below, find $v_o$ (in V).

KVL for mesh 5:

$$V_{DF} + V_{FG} + V_{GE} + V_{ED} = 0$$

$$1(I_1) + 1 + 1(I_1) + (-1) = 0$$

$$I_1 = 0$$

$$V_o = V_{BC} + V_{CD} + V_{DF} + V_{FG}$$

$$= (1)(1) + (1)(1) + (0)(1) + 1$$

$$= 3 \text{ V}$$

(1) 1
(2) 2
(3) 3
(4) 4
(5) 0.5
(6) 1.5
(7) 2.5
(8) 3.5
(9) None of the above
Question 12

The linear network in the circuit below only contains resistors and dependent sources. Measurements of the output voltage, $v_o$, are taken and the data below is collected.

<table>
<thead>
<tr>
<th>$v_s$ (V)</th>
<th>$i_s$ (A)</th>
<th>$v_o$ (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>-1</td>
</tr>
<tr>
<td>-4</td>
<td>1</td>
<td>-19</td>
</tr>
</tbody>
</table>

Find $v_o$ (in V) when $v_s = 5$ V and $i_s = 2$ A.

(1) 4  
(2) 6  
(3) 8  
(4) 10  
(5) 12  
(6) 14  
(7) 16  
(8) 18  
(9) None of the above

Since the network is linear, we can claim $v_o = a v_s + b i_s$

So $\begin{cases} -1 = 2a + 3b \\ -19 = -4a + b \end{cases}$

Solve for $a$ & $b$:  
$\begin{cases} a = 4 \\ b = -3 \end{cases}$

Therefore $v_o = 4(5) + (-3)(2) = 14$ V