Ryerson University
Department of Electrical and Computer Engineering
ELE202: Electric Circuits Analysis
Mid-Term Examination, March 2, 2012

Duration:2 hours

Student's Name: [redacted]

Student's Number: [redacted] **Section:** [redacted]

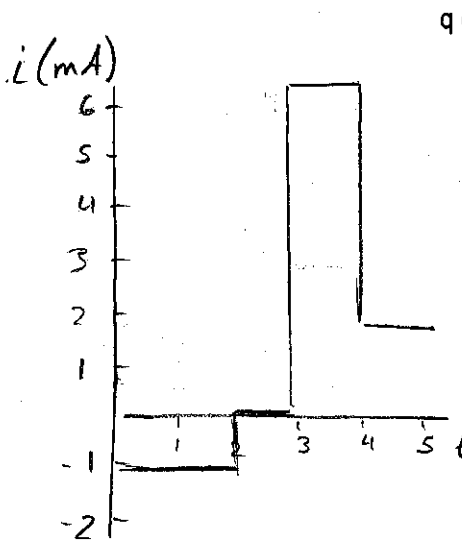
NOTES:

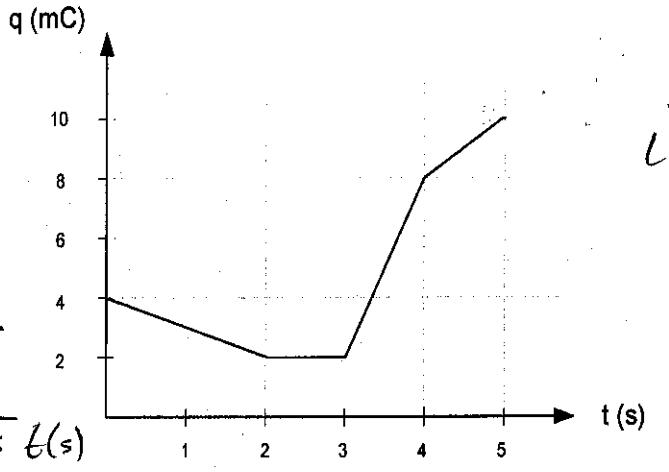
1. This is a **Closed Book** examination. No aids other than the approved calculators are allowed.
2. There are four questions. Answer all **four questions.**
3. You must **show all working**. Answers without working will receive zero marks.
4. **No questions are to be asked** in the examination hall. If doubt exists as to the interpretation of any question, the student is urged to submit with the answer paper, a clear statement of any assumptions made.

Question No.	*Mark of each question*	*Mark obtained*
Q1	25	15
Q2	25	25
Q3	25	23
Q4	25	20
Total (Out of 100):		83

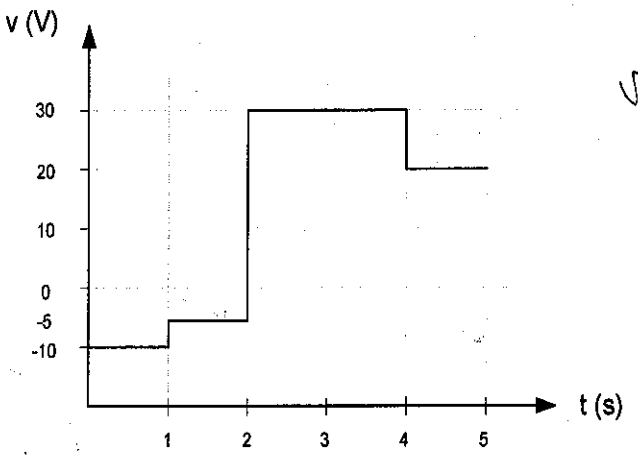
Question 1(i):

The following figures show the charge entering; and voltage across a certain element:





$$i = \frac{dq}{dt}$$



$$v = \frac{dw}{dq}$$

$$p = \frac{dw}{dt}$$

Find the current through the element at:

(a) t = 1 sec
(b) t = 2.5 sec
(c) t = 3.5 sec

a) $i = -1\ mA$ ✓

b) $i = 0\ mA$ ✓

c) $i = 6\ mA$ ✓

(a)	$-1\,mA$
(b)	$0\,mA$
(c)	$6\,mA$

Find the total energy absorbed by the device over the period $0 < t < 5$ sec :

1s $(-10V)(-1mA) = 10mJW$ ✓

2s $(-5V)(-1mA) = 5mJW$ ✓

3s $(30V)(0mA) = 0mJW$ ✓

4s $(30V)(6mA) = 180mJW$ ✓

5s $(20V)(2.1) = 41mJW$ ✓

$F_T = 235mJW$

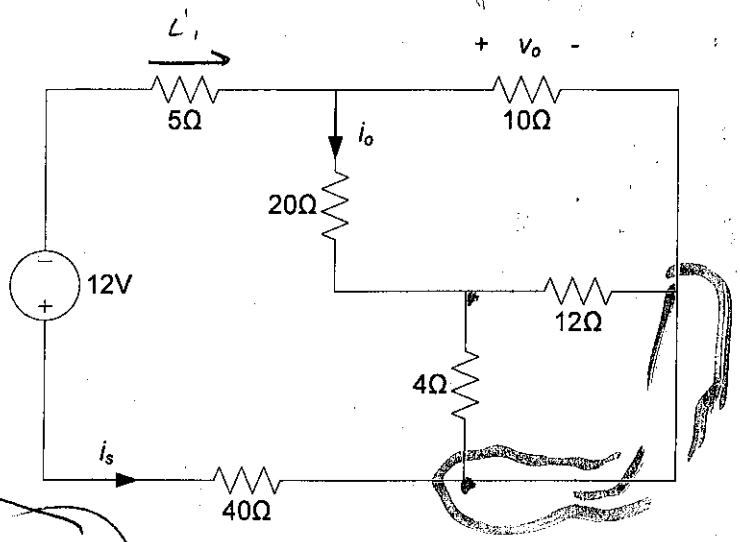
15

$E = P * t$

Total Energy =	$235mW$

Question 1(ii):

Find i_s , i_o and v_o in the following circuit:



$i_s = \frac{12V}{40\Omega} = 0.3A$

$i_1 = \frac{-12V}{5\Omega} = -2.4A$

$i_o = \frac{10}{20+10} i_1 = \frac{10}{20+10} \times 2.4 = -0.8A$

0

$v_{R20} = (20)(-0.8)$ $\quad v_o = -16V$

$= -16V$

i_s= 0.3 A

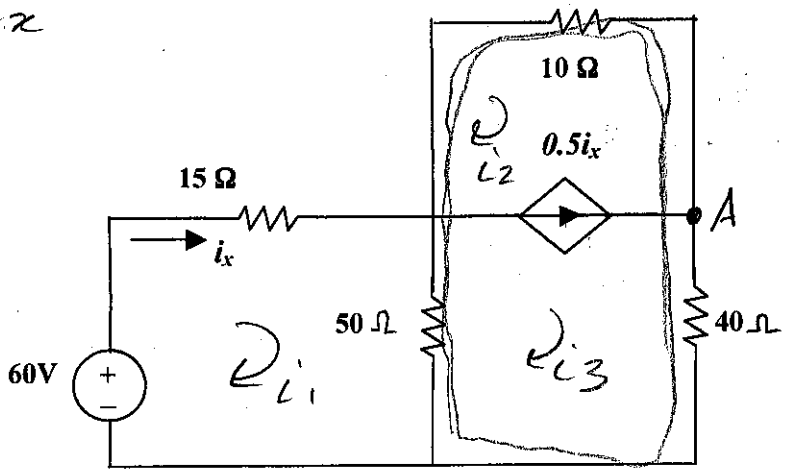
i_o= −0.8 A

v_o= −16 V

Question 2:

Use mesh analysis to solve for i_x in the following circuit:

$i_1 = i_x$



M1

$-60 + 15i_1 + 50(i_1 - i_2) = 0$

$65i_1 - 50i_3 = 60$

$13i_1 - 10i_3 = 12$ ✓

SM

$10i_2 + 40i_3 + 50(i_3 - i_1) = 0$

$10i_2 + 40i_3 + 50i_3 - 50i_1 = 0$

$-50i_1 + 10i_2 + 90i_3 = 0$

$5i_1 - i_2 - 9i_3 = 0$

@ A

$i_3 = i_2 + 0.5i_x$

$0.5i_1 + i_2 - i_3 = 0$

$i_1 + 2i_2 - 2i_3 = 0$

$$\begin{bmatrix} 13 & 0 & -10 \\ 5 & -1 & -9 \\ 1 & 2 & -2 \end{bmatrix} = \begin{bmatrix} 12 \\ 0 \\ 0 \end{bmatrix}$$

Using calculator...

$\Delta = 150 \quad \Delta_1 = 240$

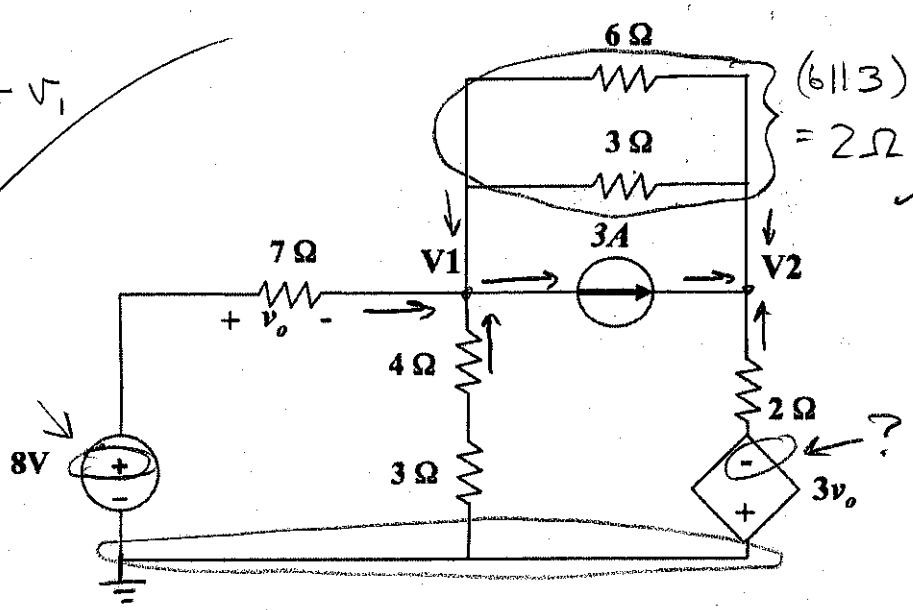
$\frac{240}{150} = 1.6\,A = i_x$ ✓

25

i_x= 1.6 A

Question 3:

Using nodal analysis, determine **V1** and **V2** in the following circuit:



$v_o = 8 - v_1$ ✓

(6||3) = 2Ω ✓

@1 ✓

$$\frac{8-v_1}{7} + \frac{v_2-v_1}{2} + \frac{0-v_1}{7} - 3 = 0$$ ✓

$16 - 2v_1 + 7v_2 - 7v_1 - 2v_1 - 42 = 0$

$-26 - 11v_1 + 7v_2 = 0$

$11v_1 - 7v_2 = -26$ ✓

@2 ✓

$$\frac{v_1 - v_2}{2} + 3 + \frac{-3v_o - v_2}{2} = 0$$ ✓

$v_1 - v_2 + 6 - 3v_o - v_2 = 0$

$v_1 - v_2 + 6 - 3(8 - v_1) - v_2 = 0$

$v_1 - v_2 + 6 - 24 + 3v_1 - v_2 = 0$

$4v_1 - 2v_2 = 18$

$2v_1 - v_2 = 9$ ✓

$-4v_2 + 4v_1 = -32$

$$\begin{bmatrix} 11 & -7 \\ 2 & -1 \end{bmatrix} = \begin{bmatrix} -26 \\ 9 \end{bmatrix}$$

Using calculator...

$\Delta = 3$ $\Delta_1 = 89$ $\Delta_2 = 41$

$v_1 = \frac{89}{3} = 29.67$ V

$v_2 = \frac{41}{3} = 13.67$ V

$\Delta = -18$ $v_1 = \frac{-198}{-18} = 11$ V

$\Delta_1 = -198$ $v_2 = \frac{-378}{-18} = 21$ V

$\Delta_2 = -378$

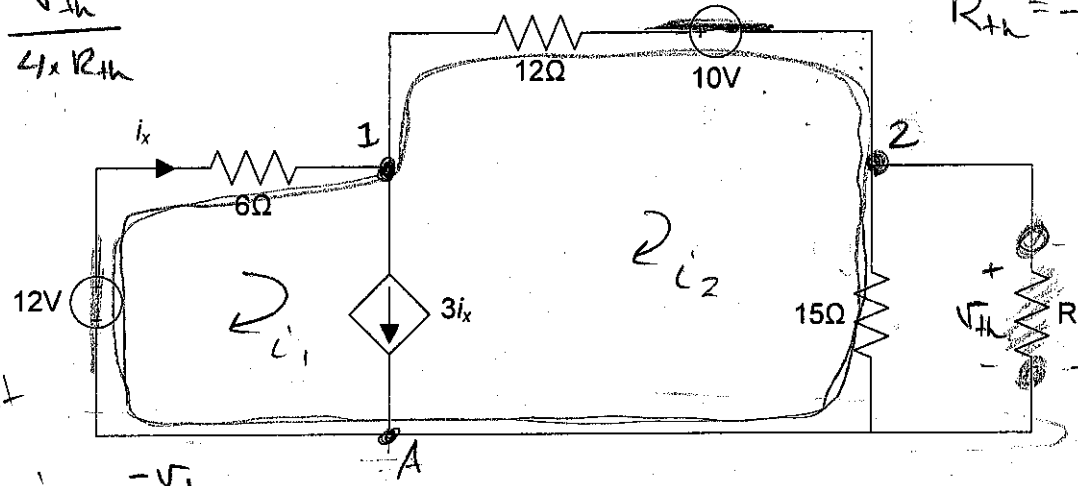
23

$V_1 = 29.67\ V$

$V_2 = 13.67\ V$

Question 4:

Find the maximum power that can be transferred to the resistor R_L in the following circuit:



$P_{MAX} = \frac{V_{th}^2}{4 \times R_{th}}$

applying current of 1A

$R_{th} = \frac{V_o}{I_o} = \frac{V_o}{1}$

Exciting circuit with 1A.

$i_x = \frac{-V_1}{6}$

@1

$\frac{0-V_1}{6} - 3i_x + \frac{V_2-V_1}{12} = 0$

$\frac{0-V_1}{6} + \frac{V_1}{2} + \frac{V_2-V_1}{12} = 0$

$-2V_1 + 6V_1 + V_2 - V_1 = 0$

$3V_1 + V_2 = 0$

@2

$\frac{V_1-V_2}{12} + \frac{0-V_2}{15} + 1 = 0$

$15V_1 - 15V_2 - 12V_2 + 180 = 0$

$15V_1 - 27V_2 = -180$

$5V_1 - 9V_2 = -60$

$\begin{bmatrix} 3 & 1 \\ 5 & -9 \end{bmatrix} = \begin{bmatrix} 0 \\ -60 \end{bmatrix}$ using calculator...

$\Delta = -32 \quad \Delta_2 = -180$

$V_2 = \frac{-180}{-32} = 5.625\,V$

$R_{th} = \frac{5.625}{1} = 5.625\,\Omega$ ✓

Solving for V_{th}

$i_x = i_1$ ✓ $V_{th} = 15i_2$

SM

$-12 + 6i_1 + 12i_2 + 10 + 15i_2 = 0$

$6i_1 + 27i_2 = 22$

@A

$i_1 = i_2 + 3i_x$

$i_1 = i_2 + 3i_1$

$-2i_1 = i_2$

$i_1 = -\frac{i_2}{2}$

$6\left(\frac{-i_2}{2}\right) + 27i_2 = 22$

$-3i_2 + 27i_2 = 22$

$24i_2 = 22$

$i_2 = \frac{11}{12}$

$V_{th} = 15 \times i_2$

$= 13.75$

Max power

$\frac{(13.75)^2}{4 \times 5.625}$

$= 8.41\,W$

20

$P_{L(max)}$= 8.4 W