Ryerson University
Department of Electrical and Computer Engineering
ELE202: Electric Circuits Analysis
Mid-Term Examination, February 2014
Duration:1.5 hours

Student's Name: [redacted]

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

NOTES:

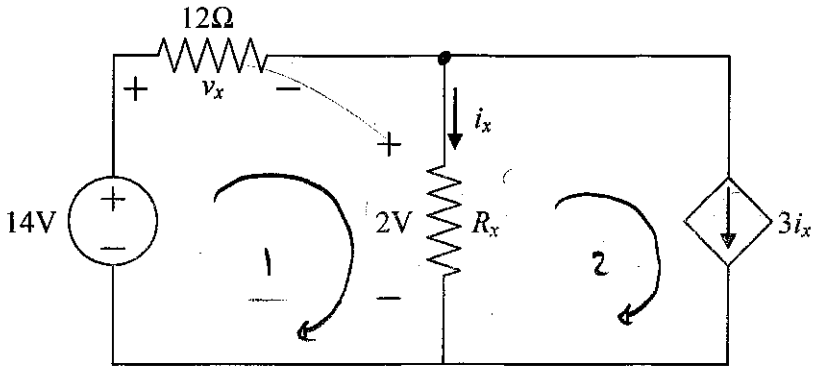
1. This is a **Closed Book** examination. No aids other than the approved calculators are allowed.
2. There are four questions. Answer all **four questions.**
3. **No questions are to be asked** in the examination hall. If doubt exists as to the interpretation of any question, the student is urged to submit with the answer paper, a clear statement of any assumptions made.

Question No.	*Mark of each question*	*Mark obtained*
Q1	25	23 A.Y.
Q2	25	24 J.S
Q3	25	25 N.M
Q4	25	20+5 p.h → p.h.
Total (Out of 100):		92+5=97 p.h.

+10

Question 1(i) (10 marks):

Find v_x, i_x, and R_x in the following circuit:



$I_2 = 3I_x$

$12I_1 + 2 - 14 = 0$

$I_1 = 1\ A$

$V_x = RI_1$

$= 12 \cdot 1$

$V_x = 12\ V$

$I_x = I_1 - I_2$

$I_x = 1 - 3I_x$

$4I_x = 1$

$I_x = 0.25\ A$

$2 = R_x I_x$

$2 = R_x (0.25)$

$R_x = 8\ \Omega$

v_x=	12 V	+2
i_x=	0.25 A	+6
R_x=	8 Ω	+2

+13

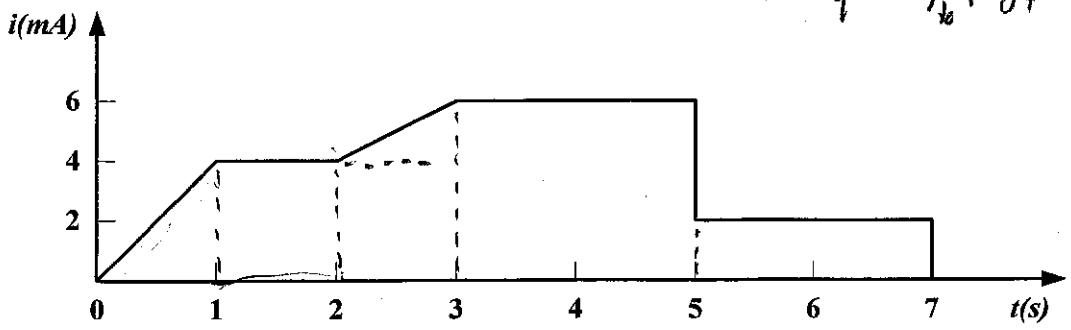
Question 1(ii) (15 marks):

The current flowing through an element is as shown in the figure below. Determine the total charge that passed through the element at:

(a) t=1 s (b) t=2 s (c) t=3 s (d) t= 5 s (e) t= 7 s

$I = \frac{q}{t}$

$q = \int_{t_0}^{t} I \, dt$



$Q_{1s} = \frac{1}{2} bh$

$= \frac{1}{2}(1)(4)$

$= 2 \text{ mC}$

$Q_{2s} = 2 + bh$

$= 2 + 1 \cdot 4$

$= 8 \text{ mC}$

$Q_3 = 8 + bh_1 + \frac{1}{2} bh_2$

$= 8 + (1)4 + \frac{1}{2}(1)(2)$

$= 8 + 4 + 1$

$= 13 \text{ mC}$

$Q_5 = 13 + bh$

$= 13 + 2(6)$

$= 13 + 12$

$= 25 \text{ mC}$

$Q_7 = 25 + bh$

$= 25 + 2(2)$

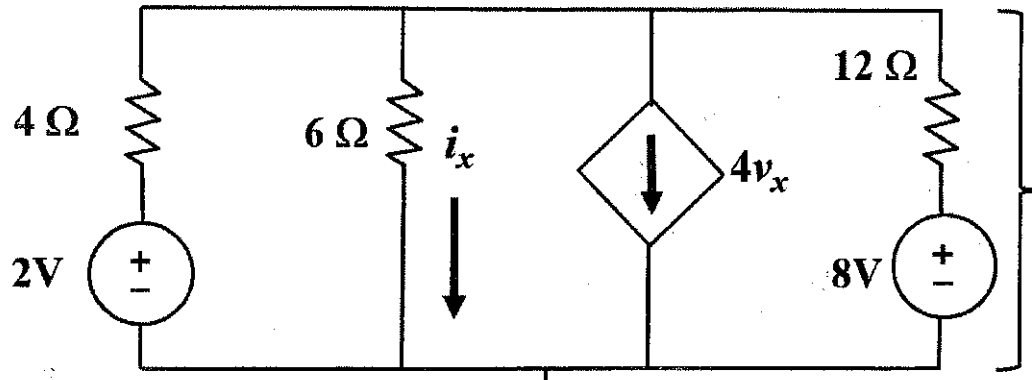
$= 29 \text{ mC}$

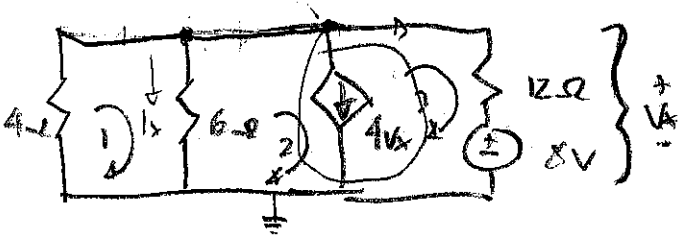
(a) Q_{1s} =	2 mC ✓ (+3)
(b) Q_{2s} =	8 mC ✗ (+1)
(c) Q_{3s} =	13 mC ✓ (+3)
(d) Q_{5s} =	25 mC ✓ (+3)
(e) Q_{7s} =	29 mC ✓ (+3)

Blank page

Question 2 (25 marks):

Find i_x and v_x using the superposition principle.

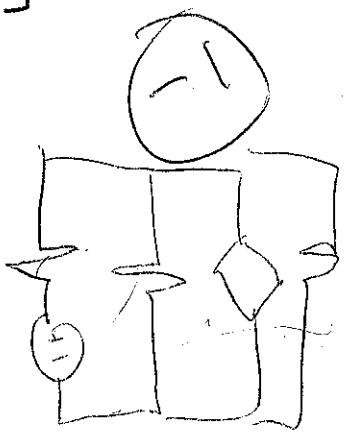




$I_x = I_1 - I_2$

$V_x = 12I_3 + 8$

$4V_x = I_2 - I_3$



① $4I_1 + 6I_1 - 6I_2 = 0$

$10I_1 - 6I_2 = 0$

$I_1 = 0.6I_2$

$4(12I_3 + 8) = I_2 - I_3$

$48I_3 + 32 = I_2 - I_3$

$49I_3 + 32 = I_2$

$V_{x2} = 0.148$ V

$I_{x2} = 0.024691$ A

(SM) $6I_2 - 6I_1 + 12I_3 + 8 = 0$

$-6I_1 + 6I_2 + 12I_3 = -8$

$-6(0.6I_2) + 6(49I_3 + 32) + 12I_3 = -8$

$-3.6I_2 + 294I_3 + 192 + 12I_3 = -8$

$-3.6(49I_3 + 32) + 294I_3 + 12I_3 = -200$

$-176.4I_3 - 115.2 + 294I_3 + 12I_3 = -200$

$129.6I_3 = -84.8$

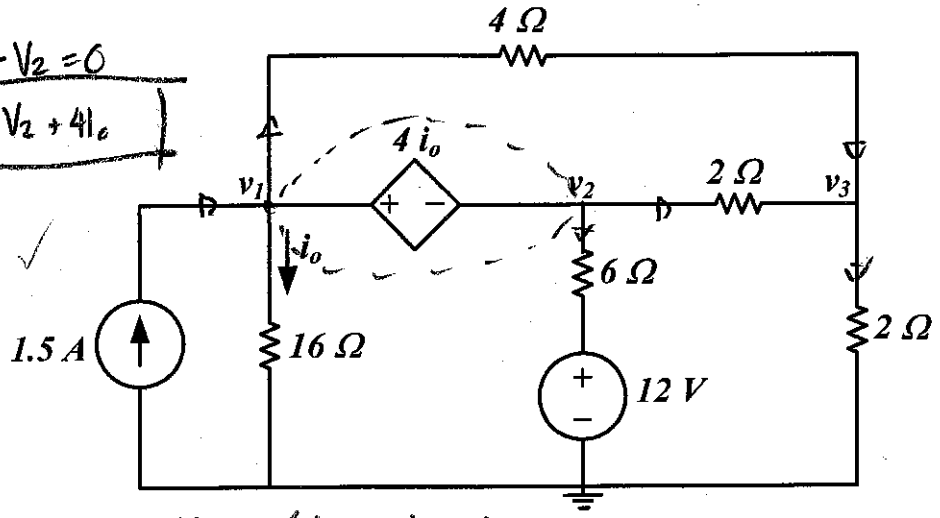
$I_3 = -0.654320987$ A

$I_2 = -0.061728$ A

$I_1 = -0.037037$ A

$i_x =$	$0.024691 + 0.018518$ $= 0.04321$ A
$v_x =$	$0.1111 + 0.148$ $= 0.259$ V

Question 3 (25 marks):
Apply nodal analysis to find the node voltages v_1, v_2, v_3 and the current i_o in the circuit shown below



(SN) $V_1 - 4i_o - V_2 = 0$

$V_1 = V_2 + 4i_o$

$i_o = \frac{V_1}{16}$ ✓

(SN) $\frac{-(V_1 - V_2)}{4} + 1.5 - \frac{V_1}{16} - \frac{(V_2 - 12)}{6} - \frac{(V_2 - V_3)}{2} = 0$ ✓

$-\frac{V_1}{4} + \frac{V_2}{4} + 1.5 - \frac{V_1}{16} - \frac{V_2}{6} + 2 - \frac{V_2}{2} + \frac{V_3}{2} = 0$

$$\frac{-5V_1}{16} - \frac{2V_2}{3} + \frac{3V_3}{4} = -3.5$$

$V_1 - V_2 - \frac{4V_1}{16} = 0$

$V_1 - V_2 - \frac{V_1}{4} = 0$

$$\frac{3V_1}{4} - V_2 = 0$$

(3) $\frac{V_1}{4} - \frac{V_3}{4} - \frac{V_3}{2} + \frac{V_2}{2} - \frac{V_3}{2} = 0$ ✓

$$\frac{V_1}{4} + \frac{V_2}{2} - \frac{5V_3}{4} = 0$$

$$\begin{vmatrix} \frac{-5}{16} & \frac{-2}{3} & \frac{3}{4} \\ \frac{1}{4} & \frac{1}{2} & \frac{-5}{4} \\ \frac{3}{4} & -1 & 0 \end{vmatrix} \begin{vmatrix} -3.5 \\ 0 \\ 0 \end{vmatrix}$$

$V_1 = 8$ V

$V_2 = 6$ V

$V_3 = 4$ V

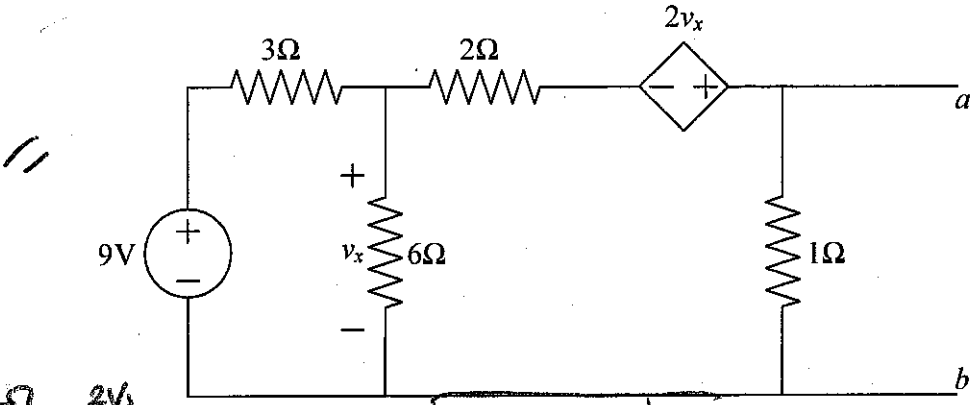
$v_1 =$	8 V	✓
$v_2 =$	6 V	✓
$v_3 =$	4 V	✓
$i_o =$	0.5 A	✓

$i_o = \frac{8}{16} = 0.5$ A

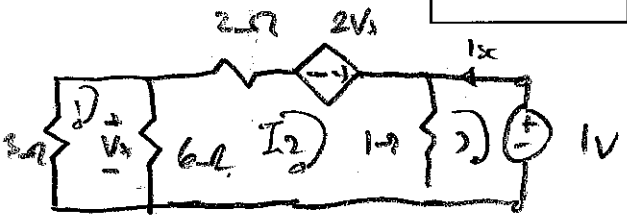
Blank page

Question 4 (25 marks): 20+5 p.4.

Find the Thevenin equivalent between terminals *a-b* of the following circuit:

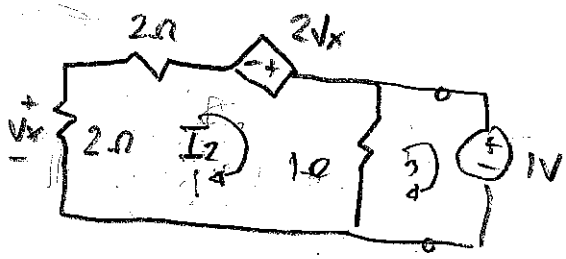


$I_3 = -I_{sc}$



* Using KVL in parallel, 3||6 still has volts V_x it needs more electric

$V_x = -2I_2$



$2I_2 + 2I_2 - 2V_x + I_2 - I_3 = 0$

$4I_2 - 2(-2I_2) + I_2 - I_3 = 6$

$9I_2 + 4I_2 + I_2 - I_3 = 6$

$9I_2 = I_3$

$I_3 - I_2 + 1 = 6$

$9I_2 - I_2 = -1$

$8I_2 = -1$

$I_2 = -0.125\ A$

$I_3 = -1.125\ A$

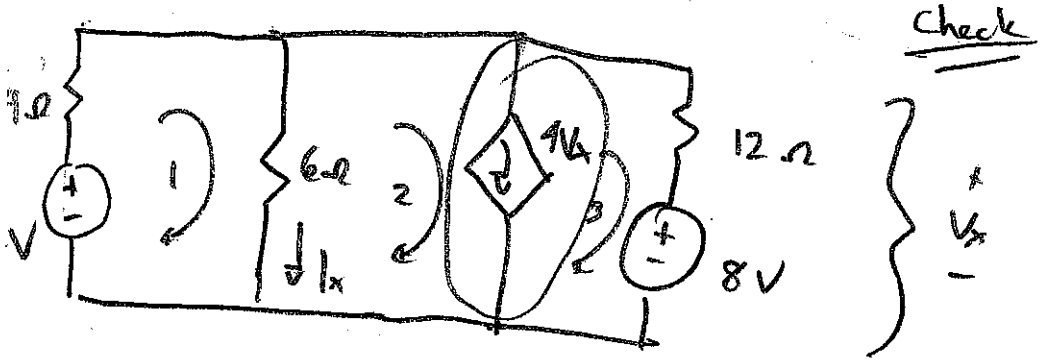
$I_s = 1.125\ A$

$R_{Th} = \frac{1}{1.125}$

$R_{Th} = 0.888\ \Omega$

$V_{th} = -2\ V$

$R_{th} = 0.888\ \Omega$



Check

SM ⇒ $4V_x = I_2 - I_3$

$V_x = 12I_3 + 8$

$I_x = I_1 - I_2$

$6I_1 - 6I_2 - 2 + 4I_1 = 0$

$10I_1 - 6I_2 = 2$

$6I_2 - 6I_1 + 12I_3 + 8 = 0$

$-6I_1 + 6I_2 + 12I_3 = -8$

$4(12I_3 + 8) = I_2 - I_3$

$48I_3 + 32 = I_2 - I_3$

$-I_2 + 49I_3 = -32$

$$\left|\begin{array}{ccc|c} 10 & -6 & 0 & 2 \\ 0 & -1 & 49 & -32 \\ -6 & 6 & 12 & -8 \end{array}\right|$$

$I_1 = 0.435185185$

$I_2 = 0.391975309$

$I_3 = -0.645061728$

$I_x = 0.04321\ A$

$V_x = 0.25926\ V$

[redacted]