UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING

ECE 110H1 S -- ELECTRICAL FUNDAMENTALS
FINAL EXAMINATION, APRIL 18, 2012

First Year -- Computer, Electrical, Industrial, Mechanical, Materials, and Track One Engineering Programs.

Examiners – B. Bardakjian, P. Herman, M. Mojahedi, H. Timorabadi and B. Wang

NAME : ______________________ ______________________
(PLEASE PRINT) Family Name Given Name

STUDENT NUMBER : ______________________

EXAMINATION TYPE C : One 8 ½ " x 11" (double-sided) aid sheet allowed

CALCULATORS : Non-programmable type (as specified in the Faculty Calendar) allowed

DURATION : 2.5 hours

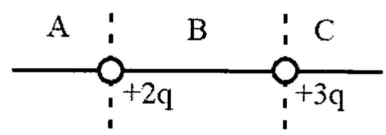
INSTRUCTIONS :
- DO NOT UNSTAPLE THIS EXAMINATION BOOK.
- Answer all six questions.
- All work is to be done on these pages. Show steps, compute numerical results when requested and state units.
- You may use the back of the preceding page for rough work.

Question	Mark
1	
2	
3	
4	
5	
6	
Total	

1. **[15 marks]** Circle the best answer in the following questions. **[1.5 marks per question]**.

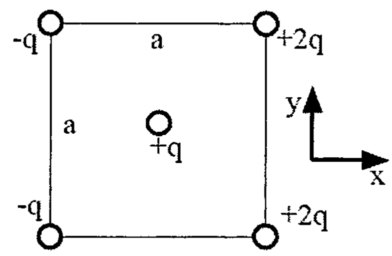
a) Two charged particles are fixed in place as shown in the figure. Determine in which region on the line a proton can be placed such that the proton remains at rest?

1) region A
2) region B
3) region C



b) Five charges are arranged at the corners and center of a square as shown below. What is the direction of the force on the center charge?

1) positive x-direction
2) negative x-direction
3) positive y-direction
4) negative y-direction



c) If a positively charged object is brought close to but not touching a conductor that is insulated from its surroundings then what is the total charge on the conductor?

1) positive
2) negative
3) zero
4) cannot determine

d) Considering a large distance from the object, determine in which case an electric field (E) is not produced.

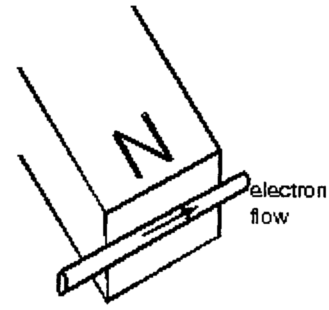
1) one stationary electron
2) one moving electron
3) a wire with an electric current flowing in it
4) a tiny triangle consisting of three equal charges (one negative and the others positive)

e) In the following formula

$$\vec{F} = q\vec{v} \times \vec{B}$$

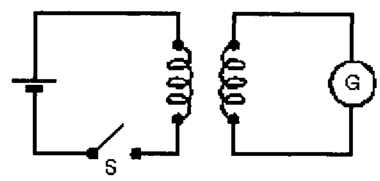
1) $\vec{F}$ must be perpendicular to $\vec{v}$ but not necessarily to $\vec{B}$
2) $\vec{F}$ must be perpendicular to $\vec{B}$ but not necessarily to $\vec{v}$
3) $\vec{v}$ must be perpendicular to $\vec{B}$ but not necessarily to $\vec{F}$
4) all three vectors must be mutually perpendicular
5) $\vec{F}$ must be perpendicular to both $\vec{v}$ and $\vec{B}$

f) The figure shows the motion of electrons in a wire which is near the N pole of a magnet. The wire will be pushed



1) toward the magnet
2) away from the magnet
3) downwards
4) upwards
5) along its length

g) In the circuit shown, there will be a non-zero reading in the Ammeter (Galvanometer) ***G***:



1) only just after S is closed
2) only just after S is opened
3) only while S is kept closed
4) never
5) only just after S is opened or closed

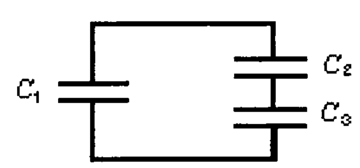
h) If *500 J* of work is required to carry a *40 C* charge from one point to another, the potential difference between these two points is:

1) 12.5 V
2) 20,000 V
3) 0.08 V
4) depends on the path
5) none of above

i) To charge a *1 F* capacitor with *2 C* requires a potential difference of:

1) 2 V
2) 0.2 V
3) 5 V
4) 0.5 V
5) none of above

j) Capacitor C_1 is connected alone to a battery initially and charged until the magnitude of the charge on each plate is 4.0×10^{-8} *C*. Then it is removed from the battery and connected to two other capacitors C_2 and C_3, as shown in the figure below. The charge on the positive plate of C_1 is then 1.0×10^{-8} *C*. The charges on the positive plates of C_2 and C_3 are:



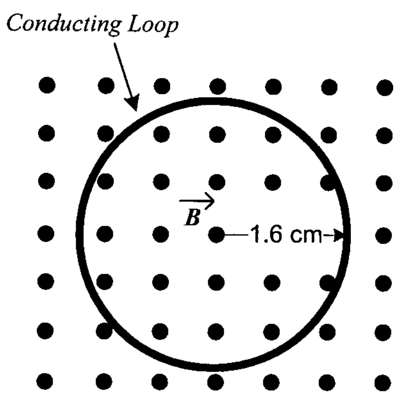
1) $q_2 = 3.0 \times 10^{-8}$ *C* and $q_3 = 3.0 \times 10^{-8}$ *C*
2) $q_2 = 2.0 \times 10^{-8}$ *C* and $q_3 = 2.0 \times 10^{-8}$ *C*
3) $q_2 = 5.0 \times 10^{-8}$ *C* and $q_3 = 1.0 \times 10^{-8}$ *C*
4) $q_2 = 3.0 \times 10^{-8}$ *C* and $q_3 = 1.0 \times 10^{-8}$ *C*
5) $q_2 = 1.0 \times 10^{-8}$ *C* and $q_3 = 3.0 \times 10^{-8}$ *C*

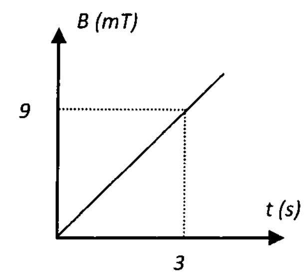
2. [**5 marks**] A uniform magnetic field (***B***) in the direction out of the page, changes in time (*t*) as illustrated in the ***B-t*** diagram below. As a consequence, a charge (*q*) flows in a conducting circular loop according to the ***q-t*** diagram below.

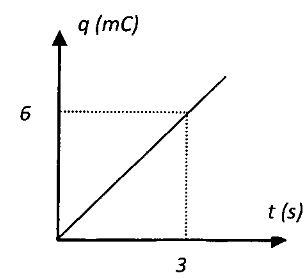
Determine:

a) Direction of current in the circular conductor. Justify. [**1 mark**]

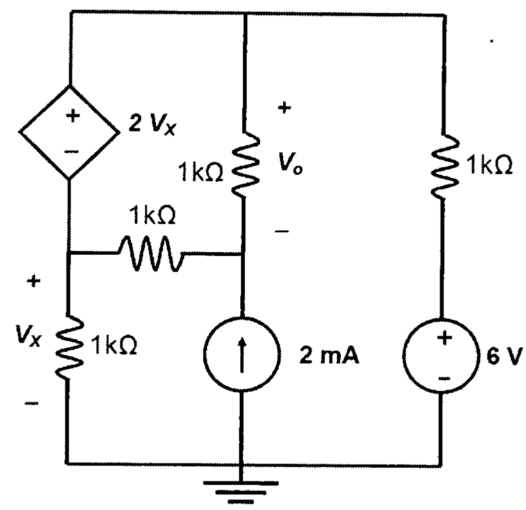
b) Resistance in the circular conductor. [**4 marks**]





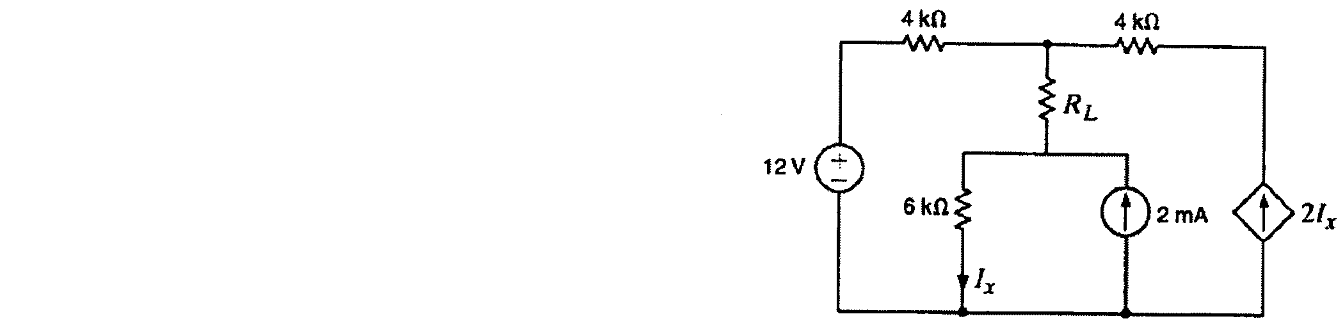


3. **[10 marks]** Find the voltage V_0 in the circuit shown.



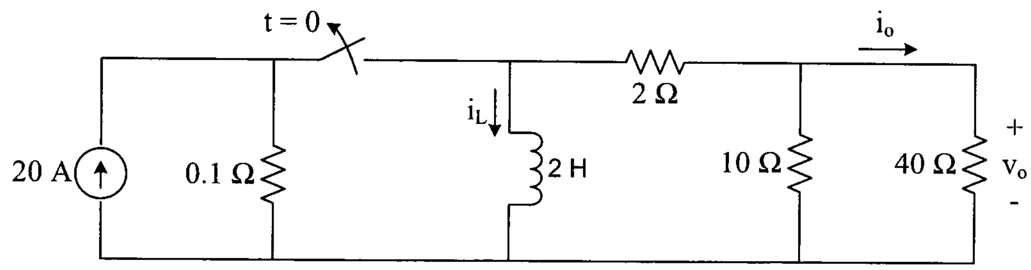
4. **[10 marks]** For the circuit shown:

a) Find the Thévenin equivalent circuit as seen by load R_L. **[8 marks]**



b) Optimize R_L for maximum power transfer from the circuit and calculate the power dissipated in R_L. **[2 marks]**

5. **[10 marks]** The switch in the circuit shown below has been closed for a long time before it is opened at t = 0.



a) Determine $i_L(t)$ for $t > 0$. **[4 marks]**

b) Find $i_o(t)$ for $t > 0$. **[2 marks]**

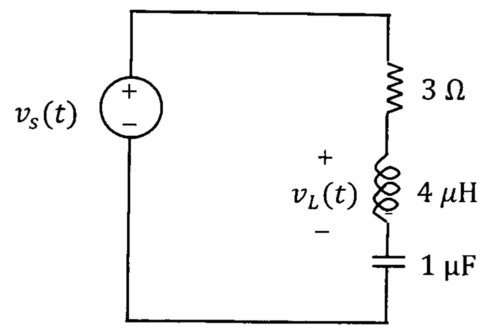
c) What is the energy stored in the inductor just before the switch opens. **[1 mark]**

d) What percentage of that energy is dissipated in the 10 Ω resistor a long time after the switch is opened. **[3 marks]**

6. **[10 marks]**

Part a) For the AC circuit shown below, $v_s(t) = 20\ \sin(10^6\ t + 125°)\ V$.

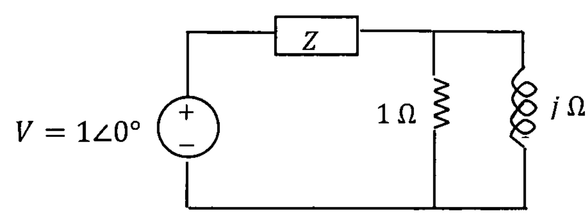
i) Redraw the circuit in the frequency domain and indicate the corresponding values of the phasor and the impedances. **[3 marks]**



ii) Determine the voltage across the inductor, $v_L(t)$. **[2 marks]**

Part b) For the circuit shown below, the frequency is 1MHz.

i) Determine the value of the impedance Z if the impedance seen by the source is purely real and equal to 1 Ω? **[2 marks]**



ii) How do you build such an impedance Z using circuit components? What are the valves of those components? **[3 marks]**