UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING

ECE 110H1 S -- ELECTRICAL FUNDAMENTALS
FINAL EXAMINATION, APRIL 13, 2011

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

Examiners – M. Graovac, A. Helmy, P. Herman, M. Mojahedi, H. Timorabadi and B. Wang

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

STUDENT NUMBER : _____

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

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

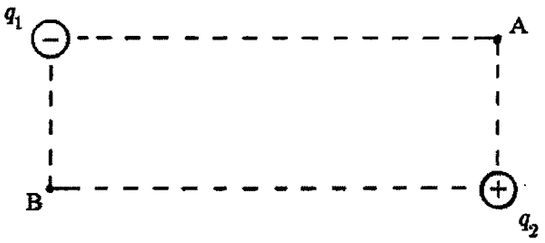
DURATION : 2.5 hours

INSTRUCTIONS :
- DO NOT UNSTAPLE THIS EXAMINATION BOOK.
- Answer all six questions.
- All six questions are of equal weight.
- All work is to be done on these pages. Show methods, compute numerical results when requested and state units.
- Place your final answer in the corresponding box. You may use the back of the preceding page for rough work.

Question	Mark
1	
2	
3	
4	
5	
6	
Total	

1. [10 marks] The following rectangle in free space has **15 cm** and **5 cm** sides with $q_1 = -5$ C, and $q_2 = 2$ C.

(a) Determine electric potential at corner **A**. **(4 marks)**



$V_A =$

(b) Determine electric potential at corner **B**. **(2 marks)**

$V_B =$

(c) Determine the external work required to move a third charge $Q_3 = 3$ C from **B** to **A**. **(3 marks)**

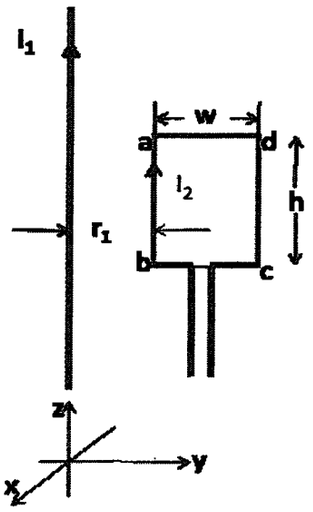
W =

(d) The electric energy of the three-charge system decreases when Q_3 is moved from **B** to **A**? **(1 mark)**

Circle one answer: ***TRUE*** ***FALSE***

2. [10 marks] For the two-wire construction shown in the figure below, $I_1 = 15$ A, $I_2 = 1$ A, $r_1 = 3$ m, $w = 2$ m, and the height $h = 4$ m.

(a) Write down an expression as a function of distance for the magnitude and direction of the magnetic field created by the current I_1.
No derivation required. **(2 marks)**



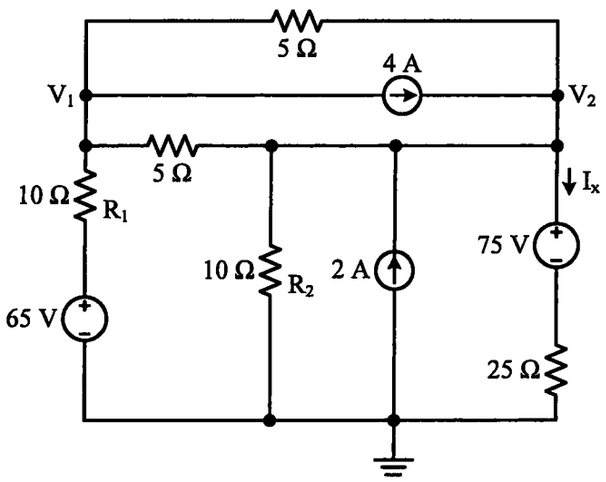
(b) Calculate the force on each of the sides, **ab** and **cd** of the rectangular wire loop, taking into account only the magnetic field created by I_1. **(3 marks)**

(c) If the rectangular wire loop is suspended and is free to move, which direction will it move to? **(1mark)**

(d) Calculate the magnitude of the magnetic flux passing through the rectangular wire loop due to I_1. **(4 marks)**

3. [10 marks] For the circuit shown below, find:

(a) the current, $\mathbf{I_x}$ **(7 marks)**



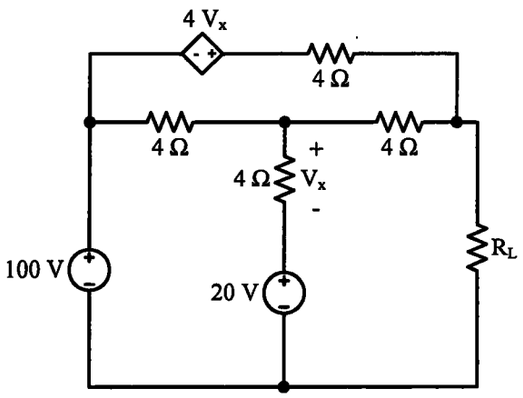
$\mathbf{I_x}$ =

(b) the power absorbed by $\mathbf{R_1}$ and $\mathbf{R_2}$ **(3 marks)**

$\mathbf{P_{R1}}$ =

$\mathbf{P_{R2}}$ =

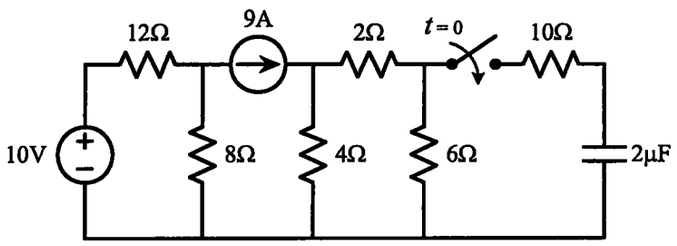
4. [10 marks] Determine the value of $\mathbf{R_L}$ that will receive the maximum transfer of power from the circuit shown.



$\mathbf{R_L}$ =

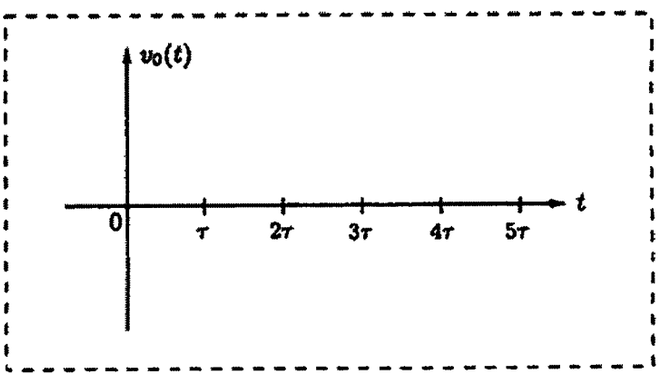
5. [10 marks] In the circuit below, assume that there is no energy stored in the capacitor at $t \leq 0$. The switch is closed at $t = 0$.

(a) Calculate the time constant τ of the circuit when the switch is closed. **(4 marks)**



τ =

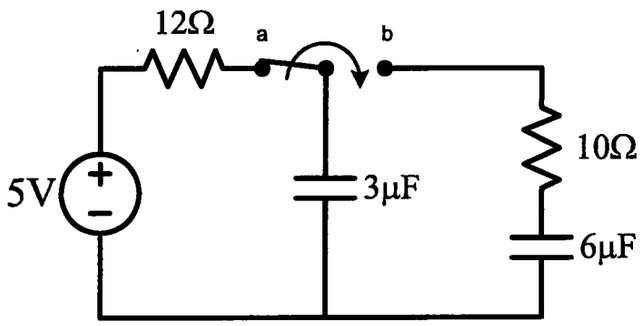
(b) Sketch the voltage across the capacitor in the space provided. Indicate the initial and final values. **(2 marks)**



(c) What is the energy that will be stored in the capacitor if the switch is closed for a long time. **(1 mark)**

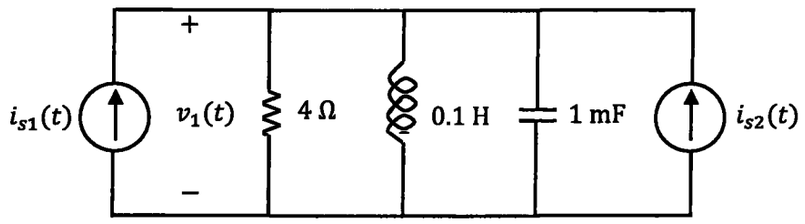
U_c =

(d) In the circuit below, assume the switch was in position **a** for a long time and that there is no energy stored in the **6 μF** capacitor. The switch is moved from position **a** to **b**. Calculate the total energy dissipated in the **10 Ω** resistor while the switch is in position **b**. **(3 marks)**



U =

6. [10 marks] For the circuit shown below, the current source is given as $i_{s1}(t) = 8\cos(200\,t)$ A and the voltage across the current source is measured as $v_1(t) = 20\sin(200\,t)$ V.



(a) Represent $i_{s1}(t)$ and $v_1(t)$ in phasor forms. **(2 marks)**

$\underline{I_{s1}} =$

$\underline{V_1} =$

(b) Draw the circuit in the frequency domain and indicate the corresponding impedances on your new circuit diagram. **(3 marks)**

(c) Determine $i_{s2}(t)$. **(5 marks)**

$i_{s2}(t) =$