UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING

ECE 110H1 S -- ELECTRICAL FUNDAMENTALS
FINAL EXAMINATION, APRIL 19, 2013

First Year -- Computer, Electrical, Industrial, Mechanical, Materials,
and Track One Engineering Programs.
Examiners – B. Bardakjian, A. Helmy, L. Qian, B. Wang and P. Yoo

($e = 1.6 \times 10^{-19}$ C, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m, $\mu_0 = 4\pi \times 10^{-7}$ H/m)

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

STUDENT NUMBER : _____

EXAMINATION TYPE : A

CALCULATORS : Non-programmable type allowed

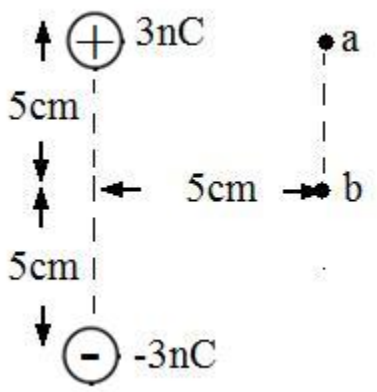
DURATION : 2.5 hours

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	

Q1 [**10 marks**]

(A) For the diagram shown below



i) Determine the electric field at location *a* (2 marks)

9.8×10^3 i – 1.9×10^3 j (N/C)

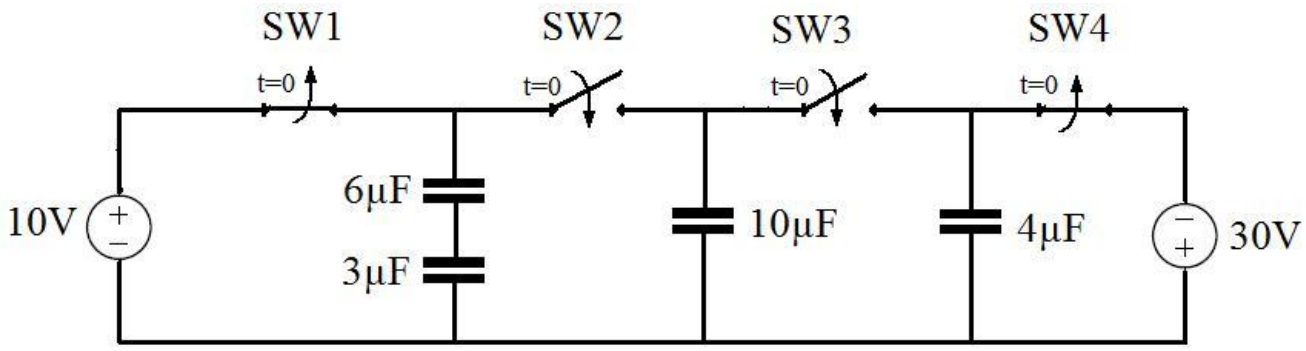
ii) Find the electric potential at location *a* (1 mark)

298.5 (V)

iii) How much external work is required to move a 0.5*nC* charge from location *a* to location *b*? (2 marks)

-0.15 (uJ)

(B) In the following circuit, SW1 and SW4 are closed while SW2 and SW3 are opened for a long time. At t = 0, SW1 and SW4 are opened and SW2 and SW3 are closed. You may assume that the $10\mu F$ capacitor has zero initial charge.



i) Determine the charge stored in each of the $6\mu F$, $3\mu F$ and $4\mu F$ capacitors for $t = 0^{--}$ (2 marks)

20 (uC)

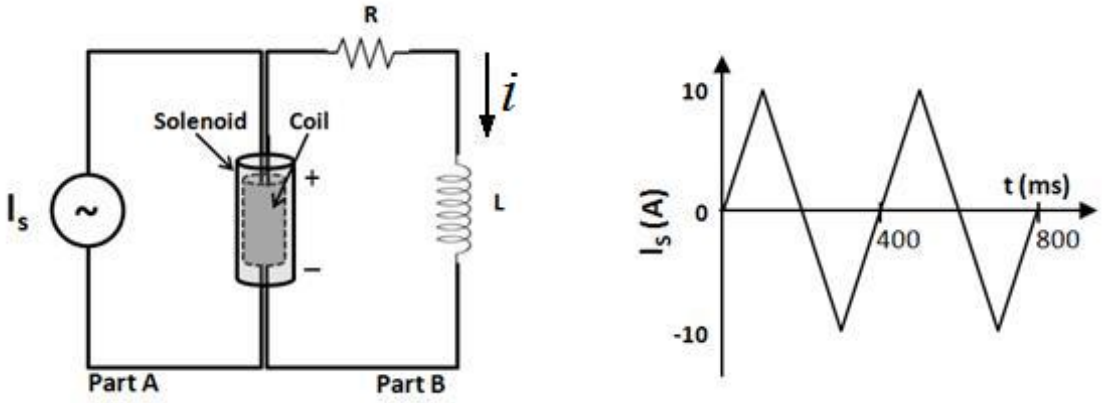
20 (uC)

120 (uC)

ii) Find the energy stored in the $10\mu F$ capacitor for $t = \infty$ (3 marks)

195 (uJ)

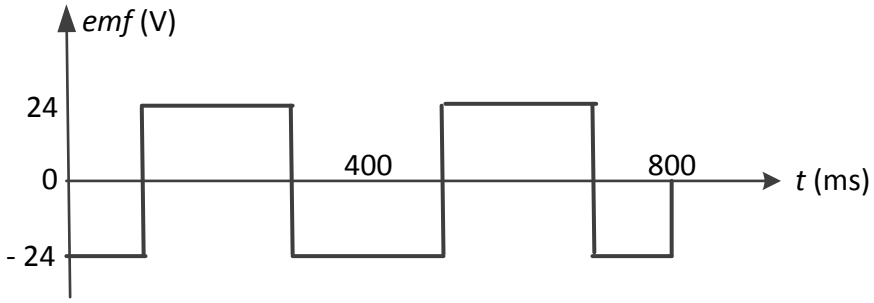
Q2 [**10 marks**] The following circuit consists of two parts that are magnetically coupled between: (Part A) a solenoid (10,000 turns, radius of 4.5 cm, and length of 20 cm) connected to time-varying current source (I_S) and (Part B) a coil (750 turns, radius of 4 cm) placed within the center of the solenoid. The coil is connected to a resistor (R) and an inductor (L) in series. Assume all circuit elements are ideal.



i) Calculate the peak magnitude of the magnetic field (B) generated within the solenoid in (Part A) (2 marks)

0.628 (T)

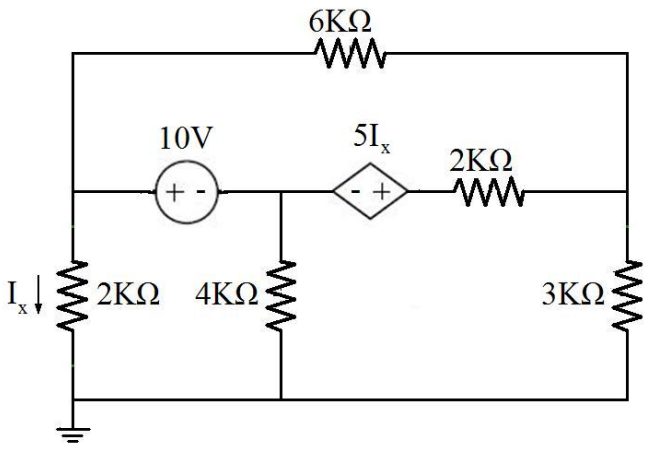
ii) Determine the emf induced in the coil and plot this variable from t = 0 to 800 ms (5 marks)



iii) Using KVL, derive an expression for the current (***i***) in (Part B) in terms of emf, R and L. You may assume zero initial voltage for the emf. (3 marks)

$$i(t) = \frac{emf}{R}(1 - e^{-\frac{R}{L}t})$$

Q3 [**10 marks**] For the circuit shown below I_x is in mA.

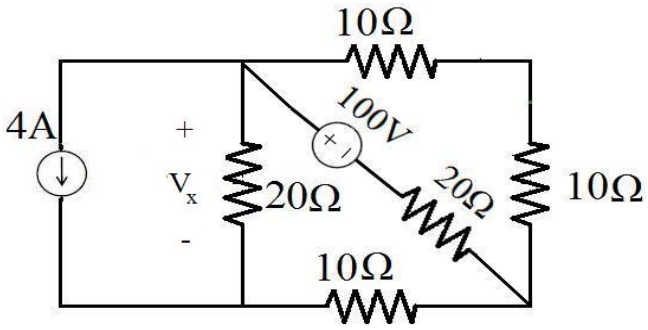


i) Find $\mathbf{I_x}$ (8 marks) 1.5 (mA)

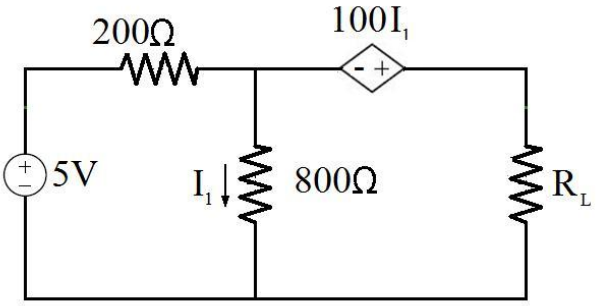
ii) What is the power delivered by the $10V$ source? (2 marks) -18.75 (mW)

Q4 [**10 marks**]

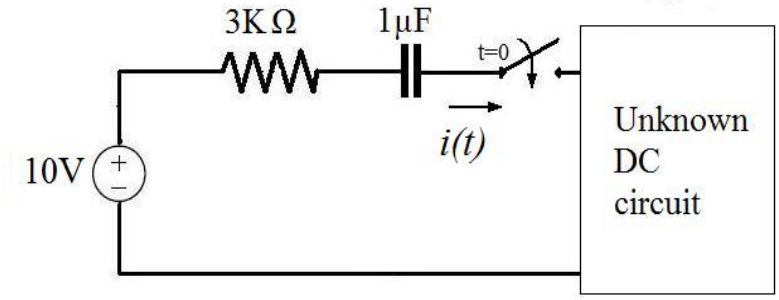
(A) Use the superposition theorem to find $\mathbf{V_x}$ (5 marks) -15 (V)

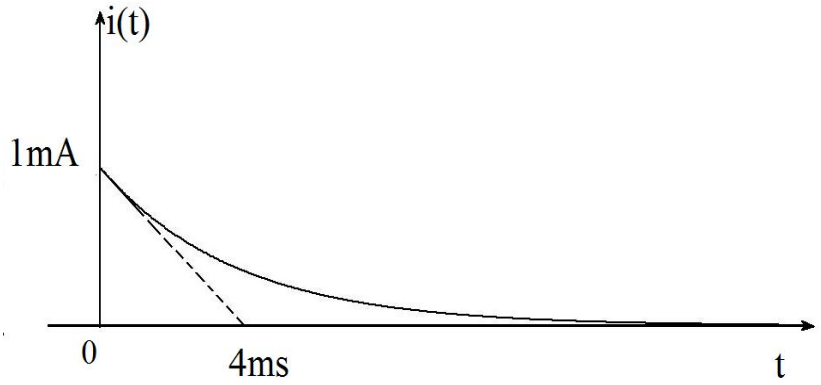


(B) For the following circuit, find the value of the load resistance ($\mathbf{R_L}$) to ensure that the maximum power is transferred to the load. (5 marks) 180 (Ω)



Q5 [**10 marks**] An unknown DC circuit (without capacitors or inductors) is connected to a 10V voltage source, a $3K\Omega$ resistor and a $1\mu F$ capacitor in series as shown. At t = 0. The switch is closed, and the current ***i(t)*** is plotted below. Find the equivalent circuit for the unknown DC circuit.

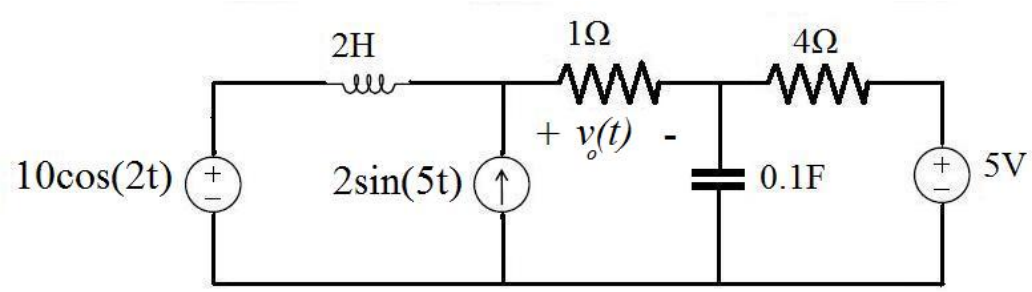




V_{th} = 6 (V)

R_{th} = 1 (k Ω)

Q6 [**10 marks**] Find $\boldsymbol{v_o(t)}$



-1 + 2.5 cos (2t – 30.8°) + 2.3 sin (5t + 10°) (V)