UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, APRIL 2006

First Year – Industrial and Mechanical Engineering Programs

ECE 110H1 S – ELECTRICAL FUNDAMENTALS

Exam. Type: A

Examiners – L. de Windt and B. Wang

NAME : (PLEASE PRINT)	FAMILY NAME	GIVEN NAME
STUDENT NUMBER :		

EXAMINATION TYPE : Type A – Paper for which no data are permitted other than the information printed on the examination paper.

CALCULATORS : ONLY Non-programmable scientific type allowed (models as specified in the Faculty Calendar).

DURATION : 2.5 hours

INSTRUCTIONS :

- DO NOT UNSTAPLE THIS EXAM. 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.

$e = 1.6 \times 10^{-19}$C, $\epsilon_o = 8.85 \times 10^{-12}$ F/m, $\mu_o = 4\pi \times 10^{-7}$ H/m

Question	Mark
1	
2	
3	
4	
5	
6	
Total	

Question 1 - Electricity and Magnetism

Part A

If the net electric field at location p in Figure 1A, is zero, what is q_3?

$q_3 =$

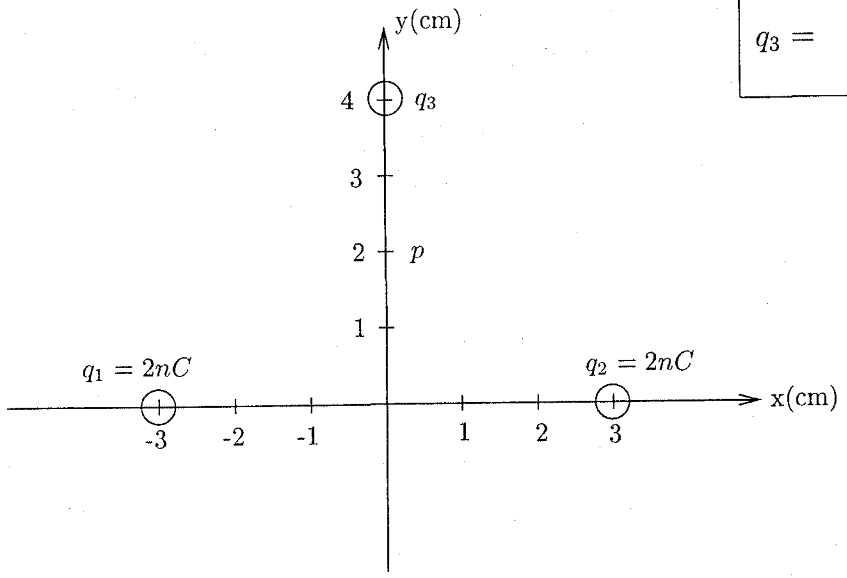

Figure 1A

Part B

Two point charges, $+Q$ and $-Q$, are placed in a region of space where the magnetic field $\bar{B}$ is uniform and points in the $-Z$ direction. The charges are moving in parallel in the x direction with speed v. The distance between the point charges is r, as shown in Figure 1B. Find the expression of the speed v, for which the distance r between the charges is not changing in time.

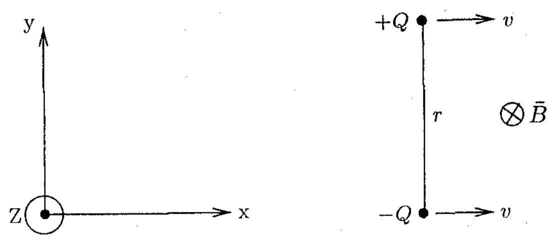

Figure 1B

$v =$

Question 2 - DC Circuits

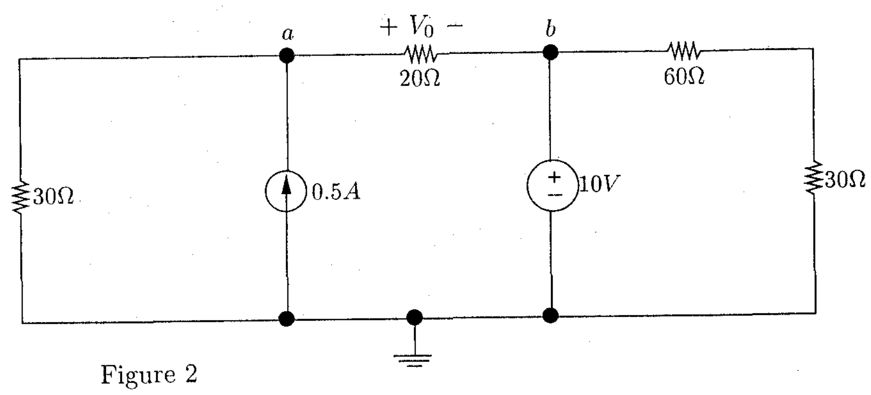

Figure 2

Part A

(i) Find the voltage, V_0 in Figure 2.

(ii) How much power is supplied by the $0.5A$ current source?

$V_0 =$

$P_{0.5A} =$

Question 2 - DC Circuits

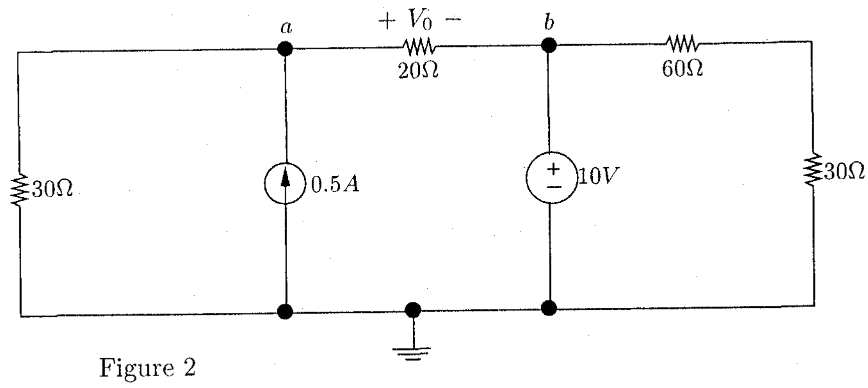

Figure 2

Part B

(i) Remove the 20Ω load from the circuit in Figure 2, then find the Thevenin equivalent circuit between the terminals a and b.

(ii) What is the maximum power that the circuit can deliver to a load?

Thevenin equivalent circuit

$P_{\max} =$

Question 3 - DC Circuits

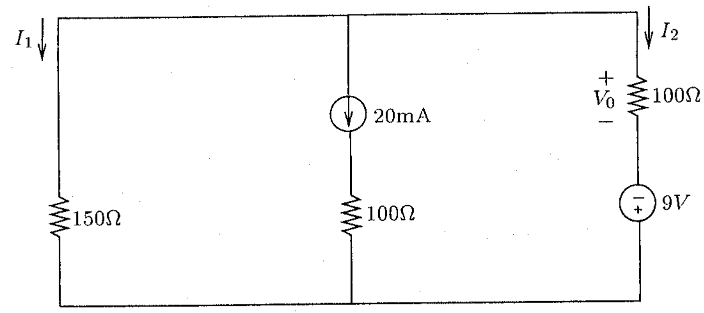

Figure 3

Part A

For the circuit shown in Figure 3, what is the contribution of the 20mA source to the current, I_1, what is the contribution of the $9V$ source to the current, I_2.

$I_1 =$

$I_2 =$

Question 3 - DC Circuits

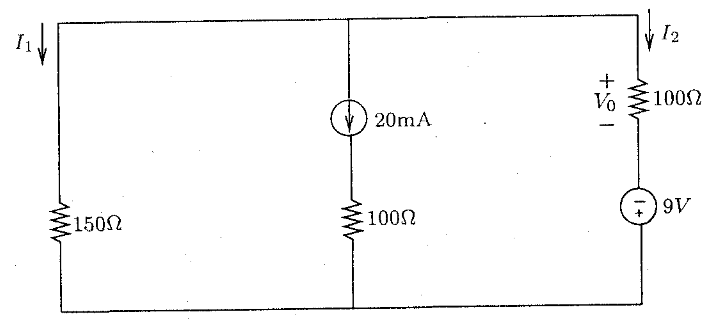

Figure 3

Part B

For the circuit shown in Figure 3, find the voltage, V_0.

$V_0 =$

Question 4

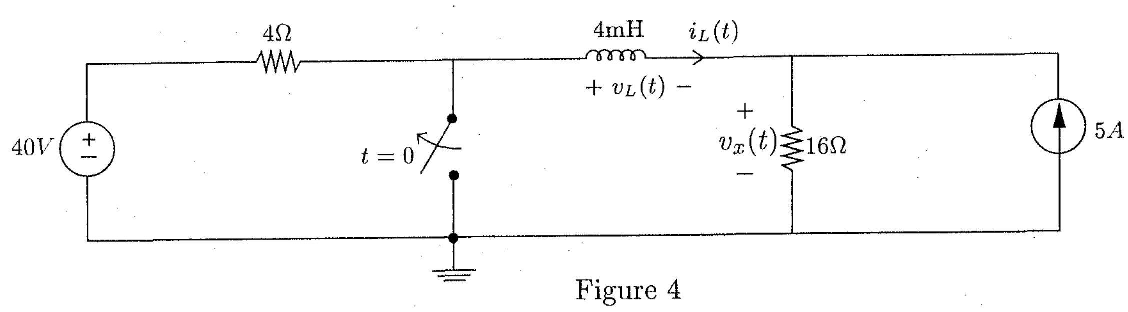

Figure 4

For the circuit shown in Figure 4, the switch has been closed for a long time before opening at $t = 0$. Determine:

i) $i_L(0^-)$
$i_L(0^+)$
$v_x(0^-)$
$v_L(0^+)$
$i_L(\infty)$

$i_L(0^-) =$

$i_L(0^+) =$

$v_x(0^-) =$

$v_L(0^+) =$

$i_L(\infty) =$

ii) The time constant τ for $t \geq 0^+$
$i_L(t)$ for $t \geq 0^+$
$v_L(t)$ for $t \geq 0^+$

$\tau =$

$i_L(t) =$

$v_L(t) =$

Question 5

Part A

Design an inverting voltage amplifier with a voltge gain of -4. You only have access to five $10k\Omega$ resistors and one operational amplifier. Assume the operational amplifier is ideal. Try to minimize the number of resistors used. Determine the input resistance of the inverting amplifier.

$R_{\text{in}} =$

Question 5

Part B

For the circuit shown in Figure 5, the operational amplifiers are ideal and operating in their linear regions. Determine:

i) The current gain i_O/i_s

ii) The output voltage v_O

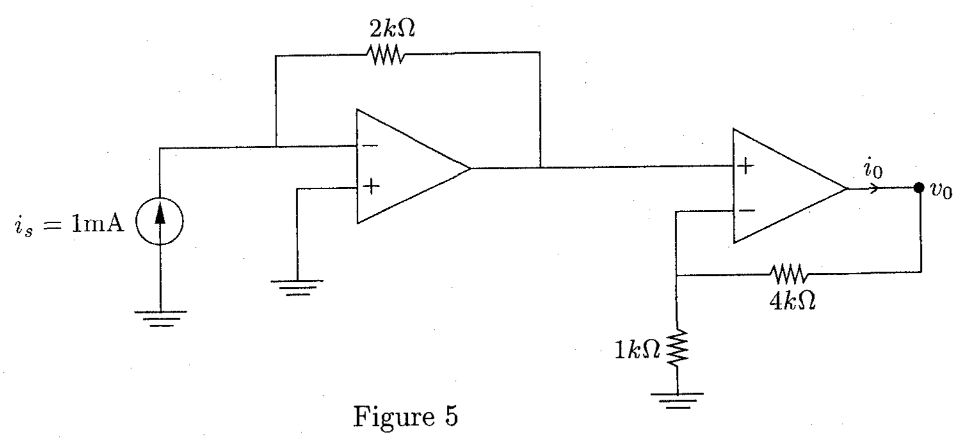

Figure 5

$i_O/i_s =$

$v_O =$

Question 6

An industrial load operates at 38.4kW, 0.8 lagging power factor as shown in Figure 6. The load voltage is $240\angle 0°\ \mathrm{V_{RMS}}$. The real and reactive power losses in the transmission line are 2kW and 3kVAR, respectively. Determine:

i) The phasor current I

ii) The impedance of the transmission line Z_{LINE}

iii) The phasor voltage V_g

I

$Z_{\mathrm{LINE}} =$

$V_g =$

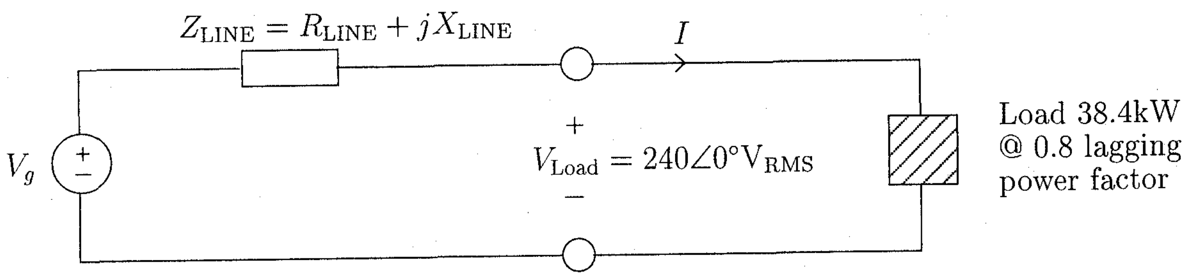

Figure 6