

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, APRIL 2007

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)	<div style="border-bottom: 1px solid black; height: 1.2em; margin-bottom: 2px;"></div> FAMILY NAME	<div style="border-bottom: 1px solid black; height: 1.2em; margin-bottom: 2px;"></div> GIVEN NAME
STUDENT NUMBER :	<div style="border-bottom: 1px solid black; height: 1.2em; margin-bottom: 2px;"></div>	

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.

$e = 1.6 \times 10^{-19} \text{C}, \quad \epsilon_o = 8.85 \times 10^{-12} \text{ F/m}, \quad \mu_o = 4\pi \times 10^{-7} \text{ H/m}$
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Question	Mark
1	
2	
3	
4	
5	
6	
Total	

Part A

Two point charges are located according to Figure 1.1 below.

- i) Determine the net electric field (magnitude and direction) at the origin.
- ii) If a third point charge ($+q$) is added to reduce the net field at the origin to zero, where (i.e. the coordinates) should the point charge be located?

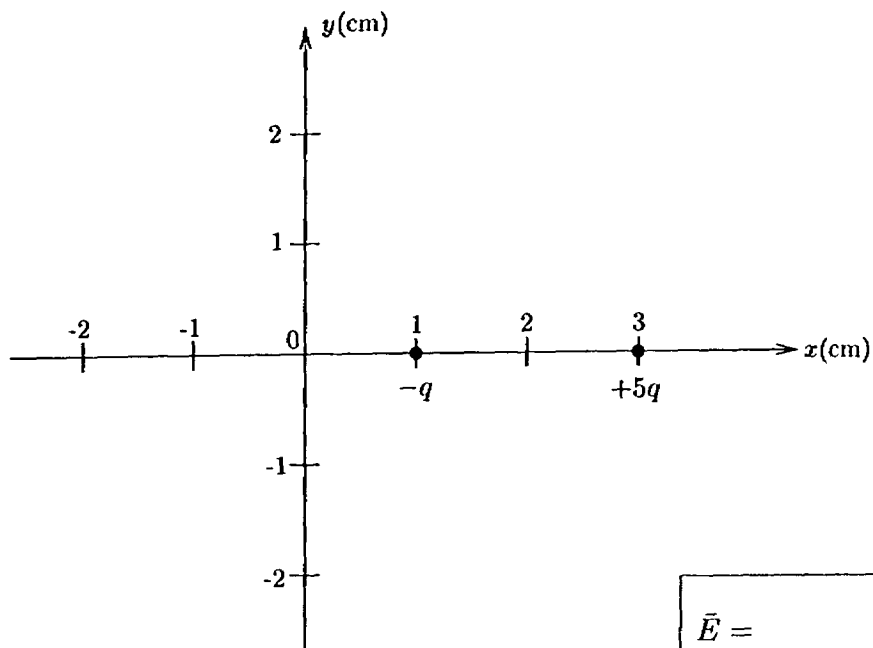


Figure 1.1

$\vec{E} =$

Coordinates:

Part B

- i) A rigid conducting loop is halfway into a magnetic field. Suppose the magnetic field begins to increase rapidly in strength. What happens to the loop (circle the correct answer below)?

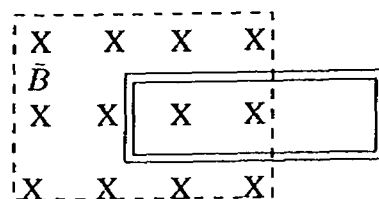


Figure 1.2

- 1) The loop is pushed upward.
 - 2) The loop is pushed downward.
 - 3) The loop is pulled to the left, into the magnetic field.
 - 4) The loop is pushed to the right, out of the magnetic field.
 - 5) The tension in the wires increases but the loop does not move.
- ii) The magnetic field in Figure 1.3 decreases from 1.0 T to 0.4 T in 1.2 s. A 6 cm diameter conducting loop with a resistance of $0.01 \, \Omega$ is placed perpendicular to \vec{B} as shown. What are the magnitude and the direction (cw or ccw) of the current induced in the loop during the 1.2 s time interval?

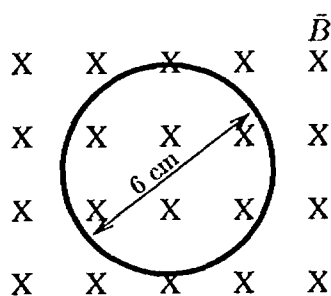


Figure 1.3

Part A

Determine the values of V_1 , V_2 , I_1 , and I_2 in Figure 2.1

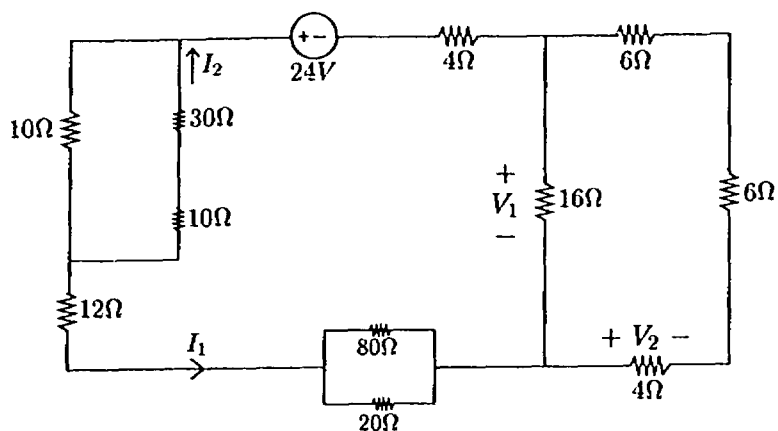


Figure 2.1

$$V_1 =$$

$$V_2 =$$

$$I_1 =$$

$$I_2 =$$

Part B

Determine the value of i in Figure 2.2.

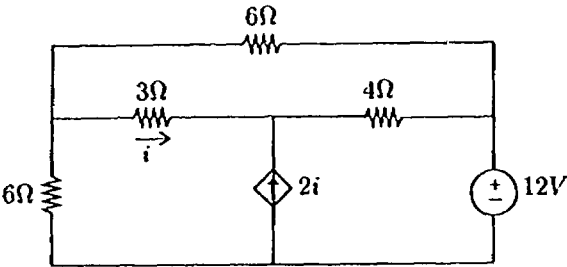


Figure 2.2

$i =$

Part A

For the circuit shown in Figure 3.1, determine the maximum power that can be transferred to the load (R_L).

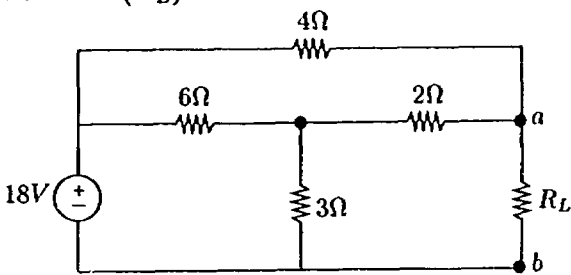


Figure 3.1

$P_{\max} =$

Part B

Find the Norton equivalent circuit for the circuit shown in Figure 3.2.

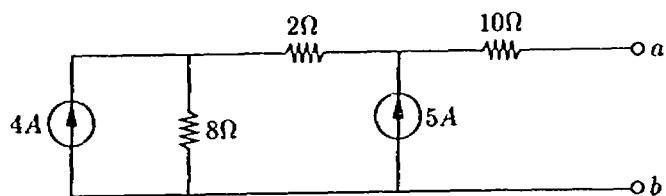


Figure 3.2

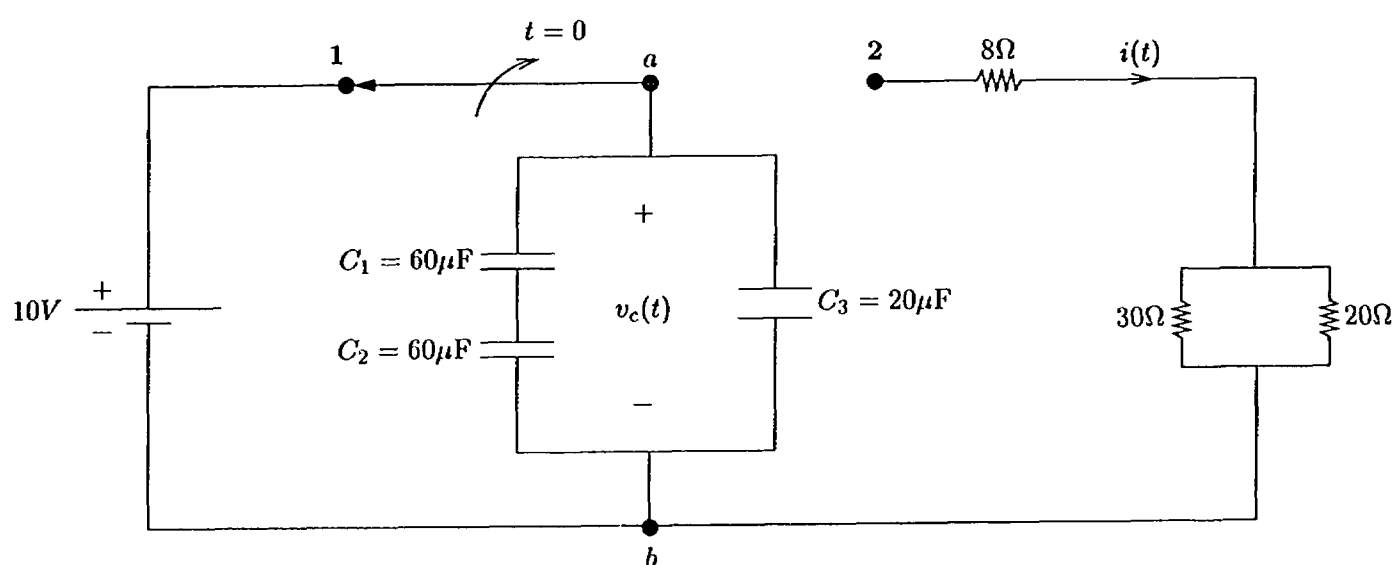
Norton Equivalent Circuit

Question 4

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In the circuit below, the switch is in position 1 until all three capacitors are fully charged. At $t = 0$, the switch moved to position 2. Determine:

- i) The charge q_1, q_2 , and q_3 on the top plate of each capacitor at $t = 0$.
- ii) The total energy stored in capacitors at $t = 0$.
- iii) The equivalent capacitance between nodes a and b .
- iv) The differential equation of the circuit for $t > 0$ in terms of $v_c(t)$.
- v) The time constant τ for $t > 0$.
- vi) The voltage $v_c(t)$ for $t \geq 0$.
- vii) The initial current through the 8Ω resistor, just after the switch moved to position 2.
- viii) The time at which the current through the 8Ω resistor decay to half the value it had just after the switch moved to position 2.



- | | |
|---|---------------------|
| i) $q_1(t = 0) =$ | v) $\tau =$ |
| $q_2(t = 0) =$ | vi) $v_c(t) =$ |
| $q_3(t = 0) =$ | vii) $i(t = 0^+) =$ |
| ii) $W_c(t = 0) =$ | viii) $t_x =$ |
| iii) $C_{eq} =$ | |
| iv) Differential Equation for $t > 0$: | |

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

- i) The input resistance seen by the $0.2V$ voltage source, R_{in1}
- ii) The voltage v_{01}
- iii) The voltage v_{02}
- iv) The voltage v_{03}
- v) The voltage v_{04}
- vi) The current i_F
- vii) The current i_0

i)	$R_{in1} =$
ii)	$v_{01} =$
iii)	$v_{02} =$
iv)	$v_{03} =$
v)	$v_{04} =$
vi)	$i_F =$
vii)	$i_0 =$

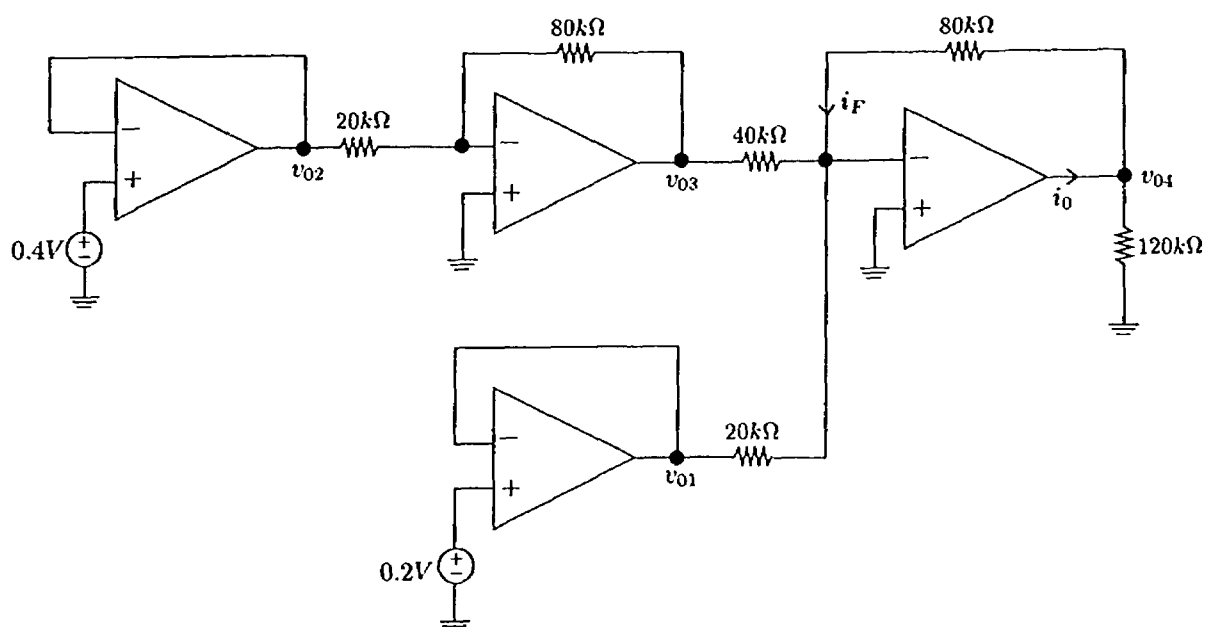


Figure 5

Question 6

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For the circuit shown in Figure 6, the voltage source is sinusoidal with magnitude of $100\sqrt{2}$ V peak, an angular frequency of 377 rad/sec and a phase angle of 0° . The voltage source supplies 1000 VA at a 0.94 leading power factor. Determine:

- i) The current $i(t)$.
- ii) The reactive power absorbed by the Load, Q_{Load} .
- iii) The impedance of the Load, Z_{Load} .
- iv) R and C or R and L . Assuming a series model for Z_{Load} .

- i) $i(t) =$
- ii) $Q_{\text{Load}} =$
- iii) $Z_{\text{Load}} =$
- iv) $R =$
 $C =$
or
 $L =$

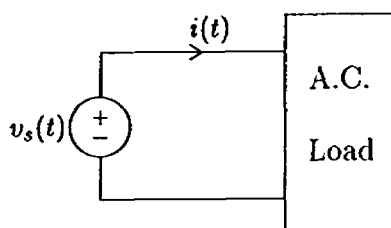


Figure 6