University of Toronto
Faculty of Applied Science and Engineering
Department of Electrical and Computer Engineering

ECE110S – Electrical Fundamentals
Term Test 2 – March 21, 2013, 6:30 – 8:00 p.m.

($e = 1.6 \times 10^{-19}$ C, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m, $\mu_0 = 4\pi\times10^{-7}$ H/m, g = 9.81 N/kg)

ANSWER ALL QUESTIONS ON THESE SHEETS, USING THE BACK SIDE IF NECESSARY.

1. Non-programmable calculators are allowed.
2. For full marks, you must show methods, state UNITS and compute numerical answers when requested.
3. Write in PEN. Otherwise, no remarking request will be accepted.
4. There is one extra blank page at the end for rough work.

Last Name: Answer Key

First Name: ______________________

Student Number: ______________________

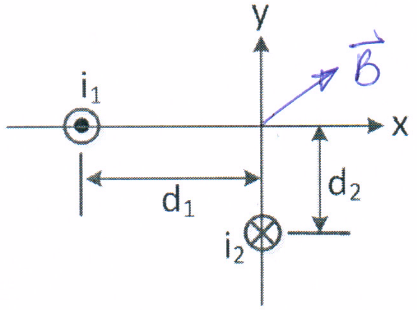
Tutorial Section:
(YOU LOSE ONE MARK FOR NOT MARKING YOUR TUTORIAL SECTION CORRECTLY)

- ☐ 01 WB342 Mon. 3-5 p.m.
- ☐ 02 GB304 Mon. 3-5 p.m.
- ☐ 03 WB342 Tue. 4-6 p.m.
- ☐ 04 GB304 Tue. 4-6 p.m.
- ☐ 05 GB404 Wed. 4-6 p.m.
- ☐ 06 BA2185 Wed. 4-6 p.m.
- ☐ 07 SF2202 Wed. 2-4 p.m.
- ☐ 08 GB304 Wed. 2-4 p.m.
- ☐ 09 GB120 Fri. 4-6 p.m.
- ☐ 10 SF3202 Fri. 4-6 p.m.
- ☐ 11 SF2202 Fri. 2-4 p.m.
- ☐ 12 WB130 Fri. 2-4 p.m.

Question	Mark
1	
2	
3	
TOTAL	

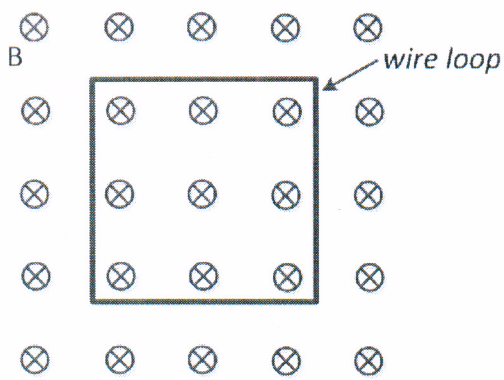
Q1 [10 marks]

A) For the two long straight wires carrying currents i_1 and i_2 respectively as shown below, find the expression for the magnetic field at the origin. (3 marks)



$$\vec{B} = \frac{\mu_0 i_2}{2\pi d_2} i + \frac{\mu_0 i_1}{2\pi d_1} j$$

B) An uniform magnetic field $\vec{B}$ (into the page) shown below, changes over time according to the following equation: $B(t) = \frac{1}{200\pi}\sin(2\pi t)$ where B is in Tesla and t is in second.



a) Find the magnetic flux (Φ_B) as a function of time, which passes through a 10 cm x 10 cm square-shape wire loop. (3 marks)

$$\Phi_B(t) = \frac{1}{2\times10^4\pi}\sin(2\pi t) \text{ Wb}$$

b) Determine the magnitude of the induced ***emf*** in the wire loop as a function of time. (2 marks)

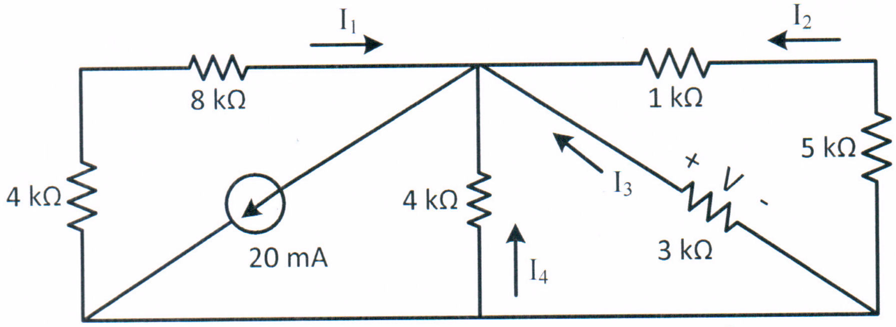
$10^{-4}\cos(2\pi t)$ V

c) What is the direction of the current (clockwise of counter clockwise) in the wire loop in period between t = **0.25 s** and t = **0.5 s**. Explain why? (2 marks)

Clock-wise direction

Q2 [10 marks]

A) In the following circuit, find the currents, I_1, I_2, I_3, I_4 and the voltage, V across the 3 kΩ resistor. (4 marks)



$I_1 = 2mA$, $I_2 = 4mA$, $I_3 = 8mA$, $I_4 = 6mA$, $V = -24V$

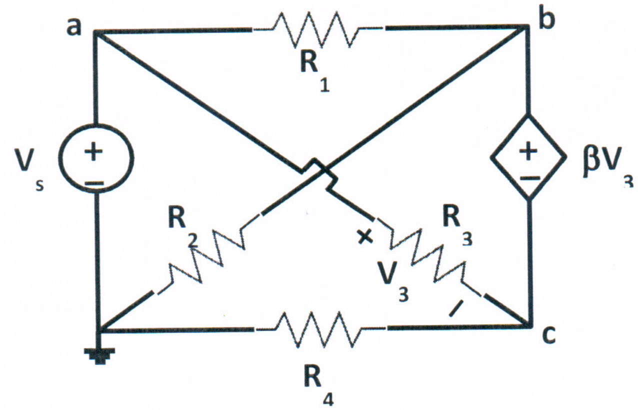
B) Determine the power dissipated by the 5 kΩ resistor. (2 marks)

80 mW

C) Let's consider the case where if current passing through any resistor exceeds 7.5 mA, the resistivity begins to change permanently. We can characterize this relationship as $\rho(t) = \rho_{\circ}(1 + kt^2)$. [$\rho_{\circ}$ is the resistivity below 7.5 mA, $k=1/4$ s^{-2} and t is time in seconds] Determine the total resistance seen by the current source in 2 seconds. (4 marks)

1.5 kΩ

Q3 [10 marks] Consider the circuit shown in the figure below.



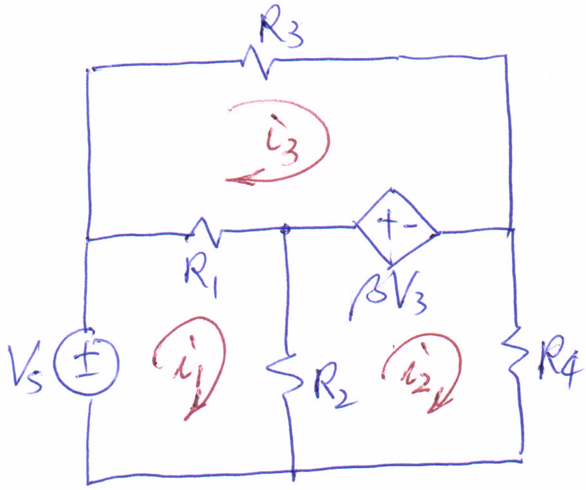
A) Use nodal analysis and write down the set of equations sufficient to solve for all nodal voltages (5 marks)

$$V_a = V_s$$

$$V_b = V_c + \beta(V_s - V_c)$$

$$\frac{V_b - V_s}{R_1} + \frac{V_b}{R_2} + \frac{V_c - V_s}{R_3} + \frac{V_c}{4} = 0$$

B) Redraw the circuit above, so that no branch crosses over another branch. Use loop analysis and write down the set of equations sufficient to solve for all loop currents (5 marks)



$$(i_1 - i_3)R_1 + (i_1 - i_2)R_2 = V_s$$

$$\beta V_3 + i_2 R_4 + (i_2 - i_1)R_2 = 0$$

$$i_3 R_3 - \beta V_3 + (i_3 - i_1)R_1 = 0$$

$$V_3 = i_3 R_3$$