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

**ECE110S – Electrical Fundamentals**
**Term Test 2 – March 22, 2012, 6:10 – 7:30 p.m.**

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.
5. One 8 1/2" x 11" (double-sided) aid sheet allowed

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**Last Name:**_____

**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.

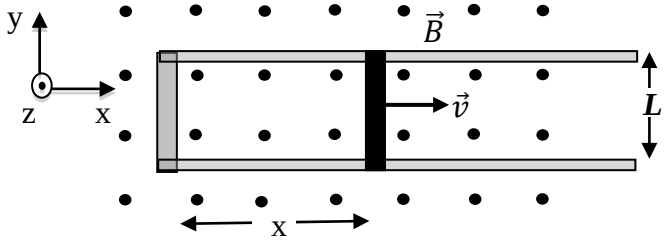
| Question | Mark |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| TOTAL | |

**Answers only (not a full solution)**

**Question 1:** [10 Marks]

A conducting rod of $R = 0.40\ \Omega$ resistance is pulled at a constant speed, $v = 5$ m/s, sliding along two frictionless and perfectly conducting rails that are separated by $L = 10$ cm as shown in the figure. The rails are connected at one end by a perfectly conducting metal strip. A non-uniform magnetic field of $B = 3\,x^2$ T is directed out of the page.

(a) Derive an expression for the magnetic flux in the area bound by the rod, the rails and the metal strip, in terms of $L$ and $x$. [**2 marks**]




$\Phi_B = L\ x^3$

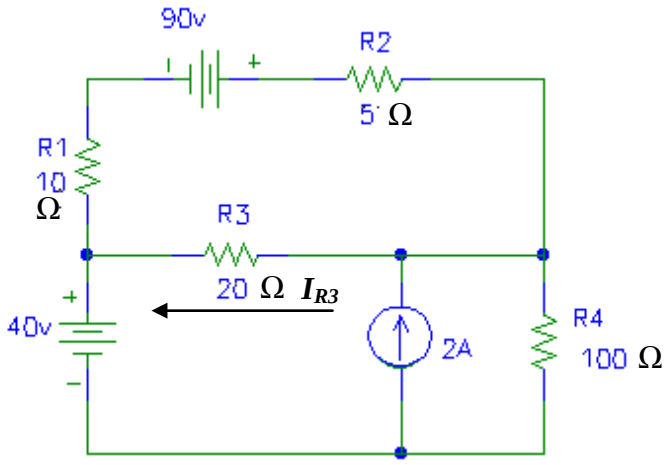
(b) Determine the direction and the magnitude of the induced current in the conductor loop at x = 0.5 m. Justify your direction choice. [**4 marks**]

$i_{ind} = 0.938$ (A) in CW direction

(c) Derive an expression for the magnitude of the external force that is required to pull the rod in terms of L, x, v and R. [**4 marks**]

$$\boldsymbol{F = \frac{9L^2x^4v}{R}}$$

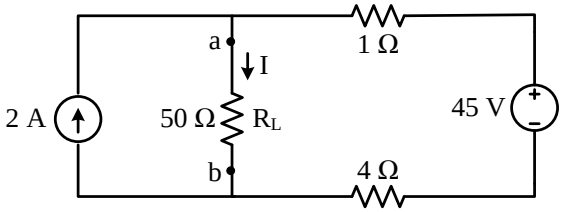
**Question 2:** [10 Marks]
Determine the current ($I_{R3}$) in the resistor $R_3$ with the direction as shown in the following Figure.




3 (A)

**Question 3:** [10 marks]

(a) Use the principle of **superposition** to find the current, **I** in the circuit shown below. **[5 marks]**




1 (A)

(b) Sketch the Thévenin equivalent circuit between the terminals, a and b (as seen by the 50 Ω load resistor). Determine the values $\mathbf{V_{th}}$ and $\mathbf{R_{th}}$ in your circuit. **[5 marks]**

$\mathbf{V_{th}} = 55$ (V) $\mathbf{R_{th}} = 5\ \Omega$