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

ECE110S – Electrical Fundamentals
Term Test 1 – February 13, 2014, 6:30 – 8:00 p.m.

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

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

1. Non-programmable calculators (Casio FX-991MS & Sharp EL-520X) 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: _____

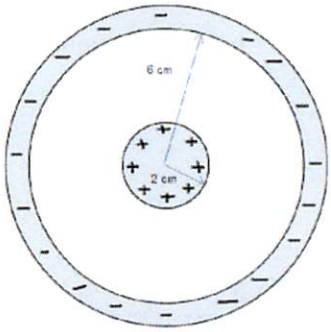
Student Number: _____

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 SF3201 Tue. 4-6 p.m.
- ☐ 04 GB304 Tue. 4-6 p.m.
- ☐ 05 GB404 Wed. 4-6 p.m.
- ☐ 06 SF2202 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 WB130 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]



- Consider two *infinitely long* concentric cylindrical conductors as shown in the figure, and having radii "r" of 2cm and 6cm, respectively.
- The inner cylinder has a positive charge and the outer cylindrical shell has a negative charge equal in magnitude to that of the inner cylinder.
- The magnitude of the electric field in the space halfway (r=4cm) between the two concentric cylinders is 9.94×10^6 N/C.

(a) What is the ***surface charge density*** on the inner cylinder? (3 marks)

$\sigma = 1.76 \times 10^{-4} C/m^2$

(b) Compute the flux through a cylindrical surface of length 10cm on the inner cylinder. (2 marks)

$\Phi = 2.5 \times 10^5 \ Nm^2/C$

(c) Compute the total flux through the outer surface of the cylindrical shell. (2 marks)

$\Phi = 0$

(d) What is the potential difference between the two concentric cylinders? (3 marks)

$\Delta V = 4.37 \times 10^5 \ V$

Q2 [10 marks] A Van de Graaff generator consists of a large, hollow metal sphere, with an outer diameter of 30 cm. It is far away from ground and other charged sources. Charge is put onto the generator at a constant rate of 1nC/second.

(a) What is the capacitance of the Van de Graaff generator? (6 marks)
(b) How long does it take to charge it to 100 kV? (2 marks)
(c) How much energy is stored by charging the generator from 0 to 100 kV? (2 marks)

Hint: Consider the Van de Graaff generator as a capacitor with only one conducting sphere, implying the other conducting sphere is at infinity.

(a) $C = 16.65$ pF

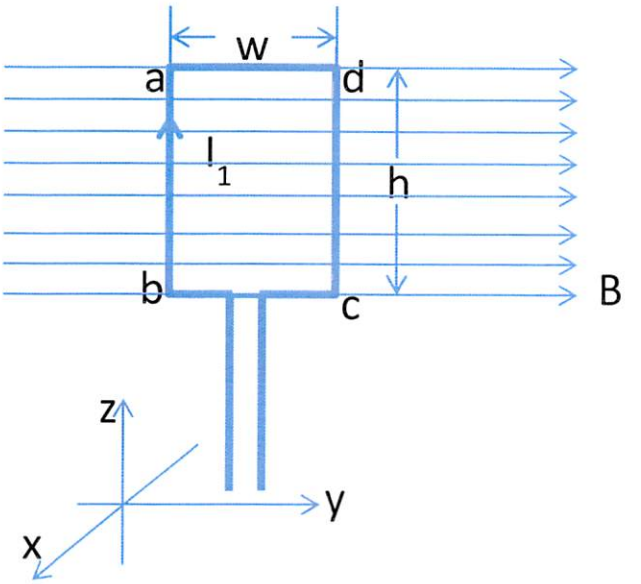
(b) 1665 second

(c) $U_c = 83.5$ mJ

Q3 [7 marks] For the wire loop shown in the figure below, I_1=10 A, w=30 mm, h=5 mm, and the magnetic field B = 15 T.

(a) Calculate the force acting on the wire segments *ab, cd* and *ad* of the loop. (5 marks)

(b) If the wire loop is suspended and is free to move; in what direction will it move? (2 marks)



(a) $\vec{F}_{ab} = -0.75\,i$ (N)

$\vec{F}_{cd} = 0.75\,i$ (N)

$\vec{F}_{ad} = 0$

(b) loop will turn clockwise, ⊥ to the x-y plane.