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

ECE110S – Electrical Fundamentals
Midterm Test 1 – February 10, 2011, 6:00 – 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" aid sheet allowed

Last Name: _____

First Name: _____

Student Number: _____

Tutorial Section
(YOU LOSE ONE MARK FOR NOT MARKING YOUR TUTORIAL SESSION 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 WB219 Wed. 4-6 p.m.
- ☐ 07 SF2202 Wed. 2-4 p.m.
- ☐ 08 WB219 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.

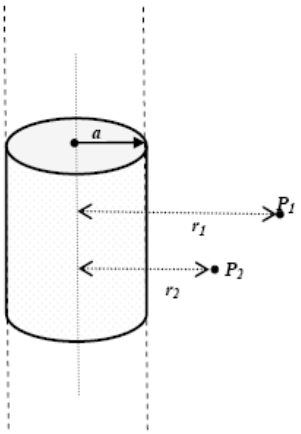
Question	Mark
1	
2	
3	
TOTAL	

1. **[10 marks]** A uniform infinitely long positive volume charge density ρ [C/m^3] is distributed inside a cylinder of radius *a*. Answer the following questions:

(a) What is the electric field ($\vec{E}$) for $0<r<a$. Identify both magnitude and direction. **(3 marks)**

(b) What is the electric field ($\vec{E}$) for $a<r<\infty$. Identify both magnitude and direction. **(3 marks)**

(c) A positive charge q has moved from point P_1 to P_2. As the result of this movement has the electrostatic potential (ΔV) increased or decreased and by how much? (Give an expression for ΔV) **(4 marks)**



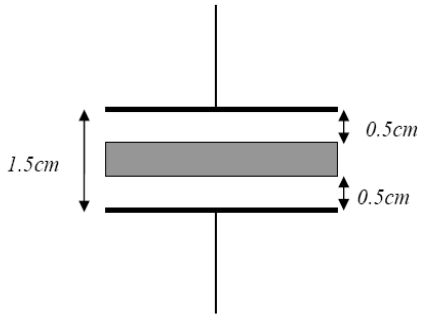
(a) $E = \frac{\rho r}{2\epsilon_0}$ radial outward

(b) $E = \frac{\rho a^2}{2\epsilon_0} \times \frac{1}{r}$ radial outward

(c) $\Delta V = \frac{-\rho a^2}{2\epsilon_0} \times \ln\left(\frac{r_2}{r_1}\right)$ voltage increased due to movement from P1 to P2

2. **[10 marks]** The figure below shows a parallel-plate capacitor with an area of $0.15m^2$. The capacitor is charged to a voltage of *120 Volts* by a battery and then the battery is disconnected. A dielectric material of thickness *0.5cm* with a dielectric constant of *3* is then inserted symmetrically between the plates as shown. Determine:

(a) Capacitance before inserting the dielectric **(2 marks)**
(b) Capacitance after inserting the dielectric **(3 marks)**
(c) Electric potential difference across the plates after inserting the dielectric **(2 marks)**
(d) Whether the dielectric is pulled in or must be pushed in and work required to insert the dielectric **(3 marks)**



(a) 88.5 pF

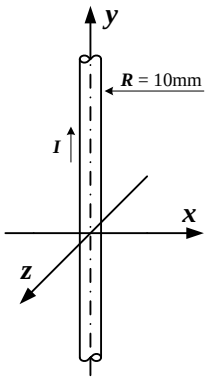
(b) 114 pF

(c) 93.16 V

(d) -142.5 nJ, pulled in

3. **[10 marks]** Consider the infinitely long conductor of radius ***R***=10 mm, located along the ***y***-axis. The 1000 A current flows in a positive ***y*** direction and is uniformly distributed through its cross-section.

(a) Where in the ***x-z*** plane is the magnetic field the greatest? Consider the area inside and outside the conductor. What is the maximum value of the magnetic field? **(3 marks)**
(b) What is the minimum value of the magnetic field inside the conductor and where does this occur. **(1 marks)**
(c) Calculate the magnitude and the direction of the magnetic field at point A (40m, 10m, 30m). **(3 marks)**
(d) Assume that 10nC charge is located at A and is moving with velocity v = 1m/s in the positive ***y*** direction. Calculate the force vector on the charged particle. **(3 marks)**



(a) Maximum at r=R, B_{max}=20mT

(b) B_{min}=0 at r=0

(c) B_A=4 microTesla perpendicular to the radius

(d) F=4x10^{-14} N radial inward (toward the conductor)