

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

ECE110S – Electrical Fundamentals
Term Test 1 – February 16, 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):

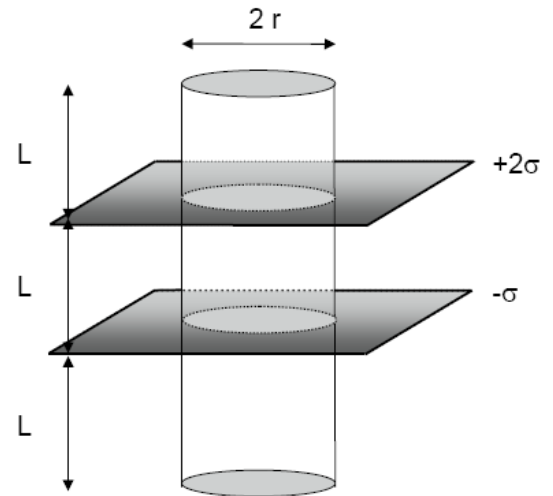
- ☐ 01 WB342 Mon. 3-5 p.m.
- ☐ 02 GB304 Mon. 3-5 p.m.
- ☐ 03 WB342 Tue. 4-6 p.m.
- ☐ 04 GB304 Tue. 4-6 p.m.
- ☐ 05 GB404 Wed. 4-6 p.m.
- ☐ 06 BA2185 Wed. 4-6 p.m.
- ☐ 07 SF2202 Wed. 2-4 p.m.
- ☐ 08 GB304 Wed. 2-4 p.m.
- ☐ 09 GB120 Fri. 4-6 p.m.
- ☐ 10 SF3202 Fri. 4-6 p.m.
- ☐ 11 SF2202 Fri. 2-4 p.m.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

Question	Mark
1	
2	
3	
TOTAL	

Answers only (not a full solution)

1. **[10 marks]** Consider two parallel, infinite non-conducting thin sheets of charge which have uniform surface charge densities of $+2\sigma$ and $-\sigma$ separated by a distance L . A cylindrical Gaussian surface with radius r , extending a distance L on either side is constructed around the planes as shown in the figure.

- (a) What is the net flux through this cylindrical Gaussian surface? **[2 marks]**



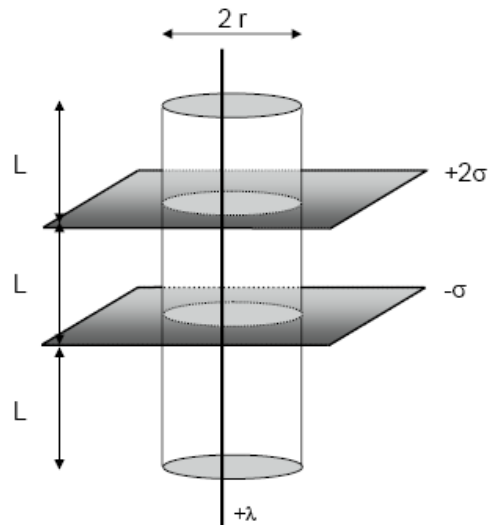
$$\frac{\pi r^2 \sigma}{\epsilon_0}$$

- (b) What is the magnitude of the electric field which emerges from its top, bottom and sides? **[3 marks]**

$$E_{\text{top}} = E_{\text{bottom}} = \frac{\sigma}{2\epsilon_0} \quad E_{\text{sides}} = 0$$

An infinite non-conducting thin line of charge which has a uniform line charge density of $+\lambda$, is positioned perpendicularly to the planar sheets of charge and aligned with the central axis of the cylindrical Gaussian surface, as shown in the picture below. Neglect the effects of the intersection of the wire with the sheets.

- (c) What is the net flux through the Gaussian surface?
[2 marks]



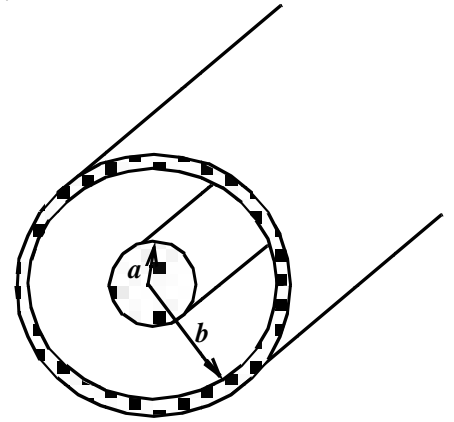
$$\frac{1}{\epsilon_0} (\pi r^2 \sigma + 3L\lambda)$$

- (d) What is the magnitude of the electric field which emerges from its top, bottom and sides? [3 marks]

$$E_{\text{top}} = E_{\text{bottom}} = \frac{\sigma}{2\epsilon_0} \qquad E_{\text{sides}} = \frac{\lambda}{2\pi\epsilon_0 r}$$

2. [10 marks] A cylindrical capacitor consisting of two coaxial cylinders of radius a and b ($b > a$) and length (L) where $L \gg b$ is shown in the Figure below. The inner shell has a total charge of $+Q$ and the outer shell has a total charge of $-Q$. Fringing may be neglected. Develop a relationship for capacitance of this device in terms of a , b , and L .

$$C = \frac{2\pi\epsilon_0 L}{\ln(b/a)}$$



3. **[10 marks]** Three thin long wires are positioned in the form of an equilateral triangle with current I_0 (I_0 is positive) as shown below. There is no electric contact between the wires where they intersect each other and you can assume the wires are infinitely long.

- a) What is the magnetic field (\vec{B}) direction and magnitude at the point o ? **[6 marks]**
- b) Initially an electron is moving along the positive x -axis at the point o . Does the trajectory of the electron change as the result of the magnetic field at o ? If yes, in which direction will the electron be deflected? **[2 marks]**
- c) Now consider another electron moving initially along the positive z -axis at the point o . Does the magnetic field (\vec{B}) do work on the electron? Justify your answer. **[2 marks]**

a) $\frac{\mu_0 I_0}{2\pi d} \mathbf{k}$

b) **yes, in +xy direction**

c) **no.**

