ECEN 3400 Spring 2014 Homework #3	**Vince Coghlan**

1) **9.18:**

The inner conductor of the coaxial cable in Fig. P9.18 can slide along the cylindrical hole inside the dielectric filling. If the cable is connected to a voltage V, find the electric force acting on the inner conductor.

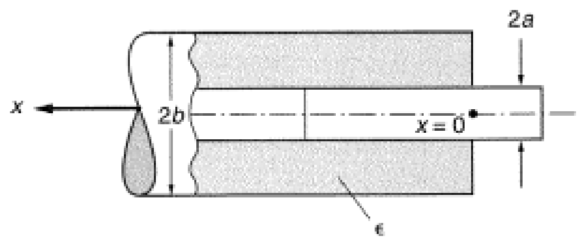


Figure P9.18 Coaxial cable with sliding conductor

The capacitance of a length of cable will be:

$$C = \frac{2\pi\epsilon_1 x}{\ln(b/a)} + \frac{2\pi\epsilon_0(L-x)}{\ln(b/a)}$$

The Electric force will be:

$$F = \frac{dW}{dx}$$

where

$$W = \frac{1}{2}CV^2 = \frac{1}{2}\left(\frac{2\pi\epsilon_1 x}{\ln(b/a)} + \frac{2\pi\epsilon_0(L-x)}{\ln(b/a)}\right)V^2$$

This means that:

$$F = \frac{V^2\pi(\epsilon_1 - \epsilon_0)}{\ln(b/a)}$$

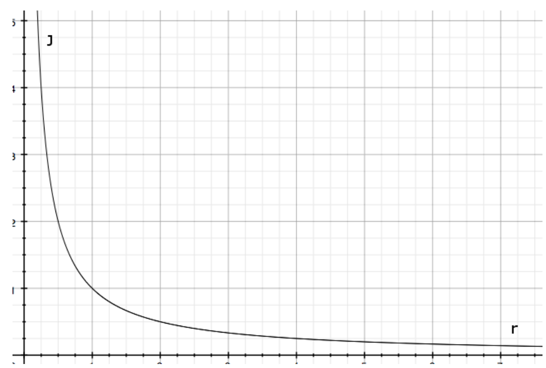
2) **10.3:**

A conductive wire has the shape of a hollow cylinder with inner radius a and outer radius b. A current I flows through the wire. Plot the current density as a function of radius, $J(r)$. If the conductivity of the wire is σ, what is the resistance of the wire per unit length?

The current density will be

$$J = \frac{I}{A} = \frac{I}{\pi b^2 - \pi a^2}$$

The resistance of the wire will be $\frac{L}{\sigma A}$ and so the resistance per unit length will be $\frac{1}{\sigma A}$ or $\frac{1}{\sigma\pi(b^2-a^2)}$.



3) **10.8:**

The resistivity of a wire segment of length l and cross-sectional area S varies along its length as $\rho(x) = \rho_0(1 + x/l)$. Determine the wire segment resistance.

Since

$$\rho(x) = \rho_0(1 + x/l)$$

and

$$R = \rho\frac{l}{A}$$

then

$$R(x) = \rho_0(1 + \frac{x}{l})\frac{l}{A}$$

$$R(x) = \frac{\rho_0 l}{A} + \frac{\rho_0 x}{A}$$

4) **11.11:**

Find the expression for determining resistivity from a four-point probe measurement, as in Fig. P11.11.

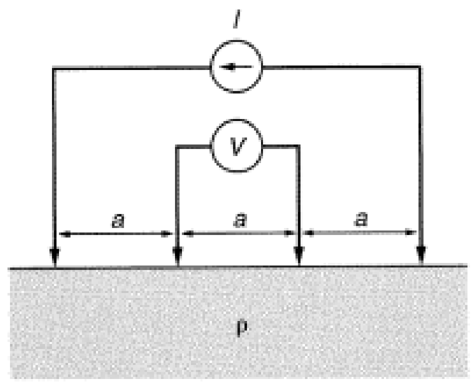


Figure P11.11 A four-point probe measurement

The potential we are going to measure can be found as in the example problem:

$$V_1 - V_2 = \int_a^{2a} [\frac{\rho I}{2\pi r^2} + \frac{\rho I}{2\pi(3a-r)^2}]dr = \frac{\rho I}{2\pi a}$$

Which becomes:

$$\rho = \frac{2\pi a(V_1 - V_2)}{I}$$

5) **12.6:**

(1) Find the magnetic flux density vector at point P in the field of two very long straight wires with equal currents I flowing through them. Point P lies in the symmetry plane between the two wires and is x away from the plane defined by the two wires. The front view of the wires is shown in Fig. P12.6a, and the top view in Fig. P12.6b. (2) What is the magnetic flux density equal to at any point in that plane if the current in one wire is I and in the other $-I$?

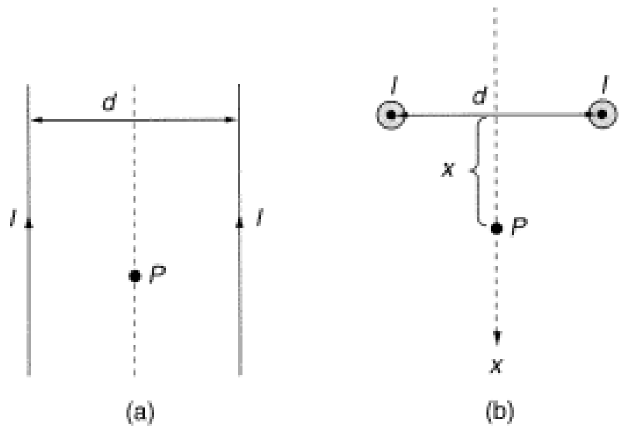


Figure P12.6 Two wires with equal currents: (a) front view, (b) top view

Using the Biot-Savart law:

$$B = \frac{\mu_0}{4\pi} \int \frac{I dl \times u_r}{r^2}$$

Since there is a field from each wire:

$$\frac{\mu_0}{4\pi} \int \frac{I dl \times u_r}{r^2 + (d/2)^2} + \frac{\mu_0}{4\pi} \int \frac{I dl \times u_r}{r^2 + (d/2)^2}$$

Since the dl components cancel eachother out, and the cross product is 1, we find:

$$\frac{\mu_0}{\pi} \frac{I d}{r^2 + (d/2)^2}$$

in case (b) the magnetic flux density will be the very same, since the vectors from each wire are the same length, and have the same angle relative to eachother. The only difference is that it points int a different direction.

6) **12.7:**

Determine the magnetic flux density along the axis normal to the plane of a circular loop. The loop radius is a and current intensity in it is I.

$$B = \frac{\mu_0 I}{4\pi} \frac{dl}{r^2}$$

$$B = \frac{\mu_0 I}{4\pi} \frac{2\pi a^2}{(z^2 + a^2)^{3/2}} = \frac{\mu_0 I a^2}{2(z^2 + a^2)^{3/2}}$$

7)

Look up the properties of nichrome wire used in many heating elements. I am leaving it up to you to decide what are the 6 most relevant properties as far as an electric heater is concerned. Summarize them in a table. List your source (it cannot be Wikipedia, but you can use it to help you find sources.)

Property (name)	Number and unit	Why it is relavant
Melting Point	1475-1710 K	You dont want the heater to get too hot
Resistivity	84-240$\cdot 10^{-8}\Omega m$	To find the heater's power useage
Specific Heat	380-500 J/kgK	To calculate how hot it gets
Thermal Conductivity	8-17 W/mK	Sounds heater related
Thermal Expansion	9-16 $10^{-6}/K$	Also sounds heater related
Elastic Limit	170-2100 MPa	Important whenever you build something

Everything found here: http://www.nickel-alloys.net/nickel_chrome_alloys.html

8)

Look up the smallest and largest current that electric fuses are manufactured for. What are they made of and how large are they? List your sources, same comment as above.

The largest I could find is 7500A here: http://www.cooperindustries.com/content/ public/en/bussmann/electrical/products/high_speed_/square_body/square_body_flushendcontact size23241000-7500a.html Its made for power distrobution usage. The smallest one I could find is 0.05 Amps, here: http://www.littelfuse.com/products/fuses/axial-radial- thru-hole-fuses/~/media/electronics/datasheets/fuses/littelfuse_fuse_242_datasheet.pdf.pdf Which is for electronics in "explosive" equipment.