Fields and Waves I - ECSE-2100
Preparation Assignment Due Sept. 11, 2000

1. Sketch the electric field lines for the following cases. In each case identify any symmetry surfaces and describe the symmetry or any properties the field has on the symmetry surfaces (for example the field is zero, one component of the field is zero, the field is tangent, etc.)

- The field of a point charge of magnitude Q Coulombs.
- The field of two point charges of magnitude Q separated by a distance d.
- The field of two point charges, one of magnitude Q and one of $-Q$ separated by a distance d.

2. Write the expression for the electric field of a unit point charge. Show that except at $r = 0$, the divergence is zero.

3. State in words Gauss's Law for electric fields.

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Preparation Assignment Due Sept. 13, 2000

1. A line of charge extends from $x = 0$ to $x = 0.2$m. The line charge density is given by $\rho_\ell = 2x$ C/m. Find the total charge on the line.

2. A line charge has linear charge density of ρ_ℓ Coulombs/meter. There is a cylindrical surface surrounding the line charge with the line charge as the axis of the cylinder. The cylinder has radius $r = a$. For there to be no electric field outside the surface $r = a$, what must be the charge density on the surface. What are the units of this charge density.

3. How far away from a point charge of 1 Coulomb do you have to be to experience a potential of 1 Volt?

Fields and Waves I - Fall 2000
Homework 2, Due Sept. 14, 2000

1. The dielectric strength of air at normal atmospheric pressure is about 30,000 V/cm. This is the value of electric field at which the air begins to break down. These discharges are called corona (not the beer). You may have heard corona near power lines. It is characterized by a sizzling sound - like something frying. As you know by now, if the conductor is small in radius the electric field becomes higher for a given charge. If the conductor is very big in radius then it is expensive and becomes very heavy and hard to support mechanically. We can approximate a cylindrical conductor of large radius by using a relatively few conductors which are distributed in space in a cylindrical configuration. These are called "bundled conductors". A typical configuration is 4 conductors on the vertices of a square. Remember, in a large cylindrical conductor the electric field is zero inside and drops off as $\frac{1}{r}$ outside. To show the effect of bundling do the following:

a) Plot the field (as a function of r) of a thin line conductor of linear charge density ρ_ℓ C/m.

b) Plot the field for a hollow cylindrical conductor of radius a and linear charge density ρ_ℓ C/m.

c) For the case of 4 conductors in a square pattern, each of which is located at radius a from the center, each of which has a line charge density of $\rho_\ell/4$ C/m, plot the electric field along a radius which bisects the line between two adjacent charges. Comment on the results.

d) Speculate on the effectiveness of increasing the number of conductors to 6, 8, etc. If you want to do some more calculations we have no objections.

2. A thin disc has a radius of 4 cm. It has a surface charge density which varies linearly with r such that the density is zero at the center of the disc and is $2 \times 10^{-6}\ C/m^2$ at the outer radius. Find an expression for the charge density and find the total charge on the disc.

3. A spherical shell has charge density between $r = 1$ cm. and $r = 3$ cm. given by $\rho_v = 2r \times 10^{-5}\ C/m^3$. Find the total charge. Find the electric field everywhere.