Phys 205 – Computational Physics, Fall 2003
Homework #3
Due Date: Friday October 10, 5pm

Notes:
• Submit your homeworks (programs in C, sample output files, and files with explanations) using the turnin program on faraday.physics.arizona.edu
• Homework problems will get full credit only if: (a) the C programs compile successfully, (b) the programs have self-explanatory comments and variable names, and (c) the programs have proper indentation.
• No credit will be give to late homeworks.

The aim of the second homework set is to help you practice your skills in calculating integrals of functions.

1. Electric Field of a Line of Charge
   Let an infinitesimally thin line of charge with length $2L$ and let $\lambda(\vec{r}')$ its charge per unit length. The electric field at an arbitrary point in space $\vec{r}$ is given by Coulomb’s law
   \[
   \vec{E}(\vec{r}) = \frac{1}{4\pi} \int_{-L}^{L} dl' \frac{\lambda(\vec{r}') (\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|^3}, \tag{1}
   \]
   where the integral is along the length of the line of charge. Use a frame of reference, in which the line of charge is along the $z$-axis so that
   \[
   \vec{r}' = z' \hat{\jmath}, \quad -L \leq z' \leq L \tag{2}
   \]
   and
   \[
   \vec{r} = x \hat{i} + y \hat{j} + z \hat{k} \tag{3}
   \]
   \[
   dl' = dz' \tag{4}
   \]
   and write a program to calculate the components of the electric field $(E_x, E_y, E_z)$ at any point with coordinates $(x, y, z)$ for a constant charge density $\lambda(\vec{r}') = \lambda_0$. (a) Plot the magnitude of the electric field divided by $\lambda_0$ along the $x$-axis (i.e., for points with $y = z = 0$) as a function of $x$. (b) What is the asymptotic behavior of the electric field for $x \ll L$? What is the asymptotic behavior for $x \gg L$?

2. Surface area of a Sphere
   The surface area of a sphere of unit length is given by the double integral
   \[
   S = \int_{\phi=0}^{2\pi} d\phi \int_{\theta=0}^{\pi} d\theta \sin \theta \tag{5}
   \]
   Write a program to calculate this double integral and show that it is equal to $4\pi$. 