# Midterm 01

**Due date Monday October 1st of 2012 at 1pm.**

One report per team is enough, but make sure everyone is listed int the authors list.

Discuss the relevant physics equation, describe you solution, show results. Report page limit is 10 pages excluding listings which should be in attachments, font size to be no less than 12pt. Email submission must have all relevant listings.

**Problem (100 points total)**
We will discuss the following problem in the 2D case.
Consider the set of $N$ charged particles distributed in the plane $xy$. The electric potential of such a system at the point $\vec{r}$ is equal to

$$V(\vec{r}) = K \sum_{i=1}^{N} \frac{q_i}{|\vec{r} - \vec{r}_i|}$$

where $q_i$ is the charge of the $i^{th}$ particle, $\vec{r}_i$ is the position of the $i^{th}$ particle, and $K = 9 \times 10^9 \ (N \ m^2)/C^2$ is Coulomb's constant.
You will be provided with a file "particles.dat" which will contain the particles' properties: 1st column corresponds to the particles' charges, 2nd column to their $x$ coordinates, and 3rd to their $y$ coordinates. Charges are given in Coulombs, and coordinates are in meters.

**Task 1**
Plot the particles' positions, depicting positively charged particles with red markers and negatively charged with blue markers.

**Task 2**
Find at least one point along $x$ where the potential is equal to zero. This point must be the closest to the $y$ axis.

**Task 3**
Someone moved a very thin and uniformly charged rod from far away to the place with the rod's end points' (x,y) coordinates equal to $(x_0, y_b)$ and $(x_0, y_t)$. So the rod is parallel to the $y$ axis. Find the total electric energy change of such a system after such a move. The rod's linear charge density is $\mu = 10^{-5} \ C/m$. Here $x_0 = -1$, $y_b = -1$, and $y_t = 1$.
Hint: you will need to integrate

$$E = K\mu \sum_{i=1}^{N} \int_{y_b}^{y_t} \frac{q_i}{\sqrt{(x_i - x_0)^2 + (y - y_i)^2}} dy$$

**Bonus is harder but it is within reach!**
**Bonus (10 points):** Find the electric energy change due to a charged rectangular sheet, brought from far away such that the corners are placed to the following coordinates: (0,2) and (1,0). The rod was removed far away before we started moving the sheet. For bonus you are not allowed to use any of the matlab integration functions (i.e. integral, integral2, quad, and so on).