Electromagnetic Fields
Exam No. 1
February 1, 2002

Solve the following 3 problems. Each problem is 1/3 of the grade. To receive full credit, you must show all work. If you need to assume anything, state your assumptions clearly. Reasonable assumptions that are necessary to solve the problem will be accepted. You are not required to evaluate integrals unless they are trivial or tare required for subsequent steps. In all problems assume properties of free space ($\varepsilon_0 = 8.85 \times 10^{-12}$ F/m) unless stated otherwise. You can write on both sides of the page. If you need additional space ASK for additional paper and make sure you write your name on it.

1. A sphere of radius b is centered at the origin and contains a volume charge density

$$\rho_v = \rho_0\left(1 + \frac{R}{b}\right)$$

The permittivity of the sphere is given as:

$$\varepsilon = \varepsilon_0(1 + kR)$$

Calculate the electric field **E** everywhere assuming the sphere is in vacuum.

2. The potential in a certain region of space is given in spherical coordinates by $V=AR^2$. Determine the volume charge density everywhere in space. Determine the total charge in a sphere of radius R centred at $R=0$. Assume permittivity of vacuum everywhere.

3. Eight equal charges q=3 nC are placed at the vertices of a cube in a vacuum. Place the cube in a Cartesian system of coordinates so that the faces are parallel to the x-y, x-z and y-z planes. The side of the cube is a=0.5m. Find
(a) The potential and the electric field intensity at the center of the cube;
(b) The potential and electric field intensity at the center of the face parallel to the x-y plane at $x=a/2$.