Introduction to Electric and Magnetic Fields B38EM

Tutorial #2 – Problems

$\varepsilon_0 = 8.85\text{x}10^{-12}\,\text{Fm}^{-1}$, $q_{e^-} = 1.6\text{x}10^{-19}\,\text{C}$

1. A charge of Q_1=3 10^{-4} C is located at M(1,2,3) and a charge of Q_2 = -10^{-4} C is located at N(2,0,5) in a vacuum. Calculate the force exerted on Q_2 by Q_1 ?

2. Two equal but opposite charges Q are separated by a distance 2a. Use Coulomb's law and the principle of superposition to find expressions for the electric field **E** and electric potential V along the line through the midpoint between the charges and normal to the axis of the charges.

3. A charge of 3 *nC* is located at the origin, and another charge of +5 *nC* is located at 0.3 m along the positive *x*-axis. Determine the position where the electric field is zero. (remark: *nC* means nanoCoulomb, which is 10^{-9} C.)

4. Four positive identical charges of 50 nC each are located at $A(1,0,0)$, $B(-1,0,0)$, $C(0,1,0)$, and $D(0,-1,0)$ in free space (the coordinates are in meters). Find the total force on the charge at A.

5. A charged circular annulus is defined by two circles of centre O, and radii *a* and R (*a*<R), of surface charge density σ.
   a. Calculate the E-field generated by these charges at a point M, of height z, situated directly above the point O.
   b. What becomes the expression of the field when *a* tends to zero. Draw the curve E(z) as a function of z.
   c. When *a* is different from zero, what becomes the expression of the field when R increases to infinity. Draw the curve E(z) as a function of z.
   d. What is the expression of the field when a tends to zero and R goes to infinity. Draw the curve E(z) as a function of z.