PH 202 Course coordinator/ Instructor**: Alika Khare**
Problem Set no. VI **Due date: Wednesday, Feb 22 & 23, 2024**

Note: All the problems in this tutorial are to be solved via multipole expansion. From the practice point of view, please try some of the problems of tut 3-5 also via multipole expansion.

1. A circular ring of radius R (in x-y plane) carries a line charge density on its rim given by $\lambda(\varphi)=K\cos\varphi$. Obtained potential due to this at any point outside the ring (r>>R). What is the equivalent dipole moment and corresponding electric field in this case?

2. A spherical shell of radius R (origin as the centre) carries a surface charge density $\sigma(\theta) = K\cos(\theta)$.
   (a) Calculate the potential far away from this sphere using multipole expansion
   (b) Calculate the dipole moment due to this charge distribution.
   (c) Corresponding electric field
   (d) Compare the solutions with that of worked out earlier by solving the Laplace's equation.

3. Consider a sphere of radius R (centred at origin) filled with a uniform volume charge density ρ_o on the northern hemisphere and that of $-\rho_o$ on southern hemisphere.
   a. Find the potential in the region $r>R$ by multipole expansion.
   b. From this obtained the very first non zero term.
   c. From part (a) above, find the expression for dipole moment.
   d. Work out the approximate expression for electric field due to the very first non zero term in the potential).

4. A spherical shell of radius R carries a surface charge density $\sigma(\theta) = K\cos(\theta)$.
   (e) Calculate the dipole moment due to this charge distribution.
   (f) Calculate the potential far away from this sphere and
   (g) Corresponding electric field.
   (h) What is the potential in the limit r $\rightarrow\infty$

5. A sphere of radius R carries a charge density $\rho(r,\theta) = K\frac{R}{r^2}(R-2r))\sin\theta$. Calculate the very first non zero term in the potential far from the sphere along the z axis.
6. A charge distribution is specified by $\rho(r,\theta) = \frac{1}{64\pi}r^2e^{-r}\sin^2\theta$. Using multipole approximation, obtain the expression for potential.