**PHYS 401 Fall 2019 5'th homework assignment. Due Nov 4'th.**

---

1. Solve problems 2.43, 2.44, 2.49 and 2.52 from the 4'th edition of the book.

2. Consider a finite region in space which carries a charge density $\rho(\vec{r})$ and consider the multipole expansion far away from this region. Show that the monopole term is invariant under the translations of the choice of origin. Find the condition under which the dipole moment is invariant under the translations of the choice of origin. Find the condition under which the quadrupole moment is invariant under the translations of the choice of origin.

3. Consider a spherical region of radius $R$ with center coinciding with the co-ordinate origin that carries a uniform charge density everwhere except an inner sphere of radius $R/2$ with center at $(R/2)\hat{k}$ which is void. Perform a multipole expansion upto an including the quadrupole in regions $|\vec{r}| >> R$.

4. Solve problems 3.10, 3.11 and 3.12.

5. Consider a square region of side length $L$ on the $xy$ with left bottom corner at the origin. The sides are conductors that are insulated from each other. All the conductor sides are grounded except the top one that is held at constant potential $V_o$.

   - Using the separation of variables technique find the potential everywhere inside the square. When you are finished check the value at the center of the square $(x = L/2, y = L/2)$; what do you infer in view of the averaging nature of the Laplacian operator?

6. Consider two concentric conductor shells of radius $R_i$ and $R_o$ with $R_o > R_i$. The inner shell is kept at potential $V_i$ and the outer shell is kept at constant potential $V_o$. Use the separation of variables technique on the form of the Laplacian operator in spherical co-ordinates.

   - Find the potential in the region between the conductors, $R_i < r < R_o$. Espescially evaluate for $r = (R_i + R_o)/2$ what do you expect in view of the averaging nature of the Laplacian operator but what do you get from your calculations? Digress on the issue if you find a discrepancy. In this respect also consider the limiting case where $R_o = R_i + \delta$ where $\delta$ is small compared to any other radius, what is the potential in the midpoint between the spheres in this case?
   - Now continue to find the potential everywhere in space. Surely the potential is a continuous function across the boundaries.
   - Find the induced surface charge density on both conductors and compare them.

7. Consider an infinitely long thin cylindrical shell of radius $R$. The upper half of is maintained at potential $V_o$ and the bottom half at $-V_o$ the contacts are insulated. Find the potential everywhere given that it vanishes at radial infinity. Find the surface charge distribution on the cylinder.