PHYSICS 110A, WINTER 2017
ELECTRICITY AND MAGNETISM

Assignment Seven, Due Friday, March 9, 5:00 pm.

[1.] Griffiths 3-24.

[2.] An infinite cylinder of radius $r = a$ has charge density $\sigma(\phi) = \sigma_0 \cos 4\phi$ on its surface. Compute the potential $V(\rho, \phi, z)$ inside (i.e. for $\rho < a$) and also outside ($\rho > a$).

[3.] Extra credit: Go through separation of variables solution of Laplace's equation in cylindrical coordinates when it is *not* legitimate to ignore the z dependence. (This is an extension of Problem [1].) Determine what the functional form is for the z and ϕ dependence. Look up online what the solutions are for the ρ dependence, just so you know in the future what those functions are.

[4.] Compute the monopole, dipole, and quadrupole terms of the potential of a point charge q located at position $\mathbf{r} = (0, 0, a)$. What is true for the case $a = 0$?

[5.] Compute the monopole, dipole, and quadrupole terms of the potential of two point charges, $+q$ located at position $\mathbf{r} = (0, 0, a)$, and $-q$ located at position $\mathbf{r} = (0, 0, b)$. Comment on the dependence of the dipole term on a, b. In particular, if you shift the charges by the same amount in the z direction, to $(0, 0, a + c)$ and $(0, 0, b + c)$, what happens to the dipole term? Enunciate a general rule about the monopole and dipole terms, the nature of the charge distribution, and the choice of origin.