# Phys 3010 Mathematical Physics
# Assignment 10

In class we looked solving Laplace's Equation in both Cartesian (x,y) and Spherical Polar (r,θ) coordinates. There is a equivalent for for Laplace's Equation in Cylindrical Polar (r,φ) coordinates

$$\frac{1}{r}\frac{\partial}{dr}\left(\frac{r\,\partial V}{dr}\right)+\frac{1}{r^2}\frac{\partial^2 V}{d\varphi^2}=0$$

1. Assume a solution of the form V(r,φ) = R(r)Φ(φ) and separate the equation into a LHS which only contains r and a RHS which only contains φ.
2. Set each side to be the same constant (k).
3. Start by solving the ordinary differential equation for Φ(φ). Show that the solution can written in the form Φ = A cos(λφ) + B sin(λφ), where $\lambda^2 = k$.
4. There is a physical restriction which requires that V be single valued, that is if you circle the z axis once (φ→φ+2π) then V (and so Φ) must be unchanged. Use that restriction to argue that λ must be an integer (n).
5. Now look at the differential equation for R, with k set equal to $n^2$. Solve that equation.
6. Finally write down the solution for V.