Physics 301-24
Assignment 2

1. Multiconnected Stokes Thm

a)Consider a surface with a hole in the middle. There are two ways of looking at this. Teh first is to put the "origin" of the coordinate system in the hole and to make the edge of the hole to lie at $x^2 = .5$ and the other outer edge to lie at $x^2 = 1$. The second is to make it into a single connected piece by cuting the surface in a line from the inner hole edge to the outer edge. Argue that the two give the same result. (Hint: what happens with the line integral from the cut surface along the cut edge(s)

2.) Gauss's law and Stokes law.

i)In a conductor, there can be no static electric field, because an electric field will cause the charges to move around, until the electric field inside is 0. The moved around charges will be deposited in a thin layer on the surface of the conductor.

Using Gauss's law and Stoke's law, what will be the direction of the electric field be just outside the conductor.

ii) In a type 1 superconductor the magnetic field is zero inside the superconductor. What will the direction be of the magnetic field be just outside the superconductor. (In this case the currents will be moved to a thin layer on the surface and will be distributed so as to cancel the magnetic field inside.)

3. Consider an electric potential $\phi(x, y, z) = |x|$, What is the electric field everywhere? Show that there is no charge anywhere except along the $x = 0$ surface. What is the charge per unit area along the $x = 0$ surface. (Use the definition of the electric field as a function of ϕ? What is the divergence of the electric field.

4. In a space free of charges, show that the potential cannot have a minimum or maximum. What is the condition that the potential have an extemum (minimum, maximum or saddle point). What is the condition on the second derivatives that the field have a maximum? Why can this not occur for a potential in free space. (Use Cartesian coordinates).

5. Consider a cylindrically symmetric electrical potential (ie, it is indepndant of z and θ where the metric is

$$ds^2 = dr^2 + r^2 d\theta^2 + dz^2 \tag{1}$$

What is the equation for the potential. Assume that for r¿0 are no charges. What are the solutions for the potential equation given the above conditions. Using Gauss's law, what is the charge per unit length at $r = 0$ of the solutions inside a clinder of height $\delta z = 1m$ of your possible solutions.