

**Assignment 3      Math 451      Spring 2009**  
**Due: 12N Friday 15 May**

**Reading**

*Curved Spaces:* 5.1-5.2

**Exercises**

Write in concise, clear *sentences* (incorporating symbolic notation and computations).

- 1) At a point  $p$ , a surface  $S$  can be expressed as the graph of a function  $z = f(x, y)$  over a patch of the plane  $T_p S$  that's tangent to  $s$  at  $p$ . Note that  $x$  and  $y$  are rectangular coordinates on  $T_p S$  in which  $p$  is given by  $(0, 0, 0)$ .

By construction,  $f_x(0, 0) = f_y(0, 0) = 0$ . Show that under a rotation

$$(x, y) = R(u, v) = (u \cos \theta - v \sin \theta, u \sin \theta + v \cos \theta)$$

about the  $z$ -axis  $f$  transforms into a function  $g(u, v) = f(R(u, v))$  such that not only is  $g_u(0, 0) = g_v(0, 0) = 0$ , but

$$g_{uv}(0, 0) = g_{vu}(0, 0) = 0$$

as well.