

Justify every claim formally! Whenever you use a theorem, specify which one you use and explicitly verify that its assumptions are satisfied!

1. Consider the function $f(x, y, z) = \sqrt[3]{x^3 + y^3 + z^3}$. Calculate directional derivatives of f at $(0, 0, 0)$ in all directions. Is f differentiable at the point $(0, 0, 0)$? In case it is, determine $Df(0, 0, 0)$.
2. Consider the function $f(x, y) = \frac{x+y}{x^2+y^2} \ln(1+xy)$. Is it possible to extend f so that the extension is defined on $B(\mathbf{0}, 1)$ (i.e., an open ball of radius 1 centered at the point $(0, 0)$) and differentiable at every point of $B(\mathbf{0}, 1)$?
3. Determine the tangent plane to the torus

$$A = \{(x, y, z) : (x^2 + y^2 + z^2 + 12)^2 - 64(x^2 + y^2) = 0\}$$

at the point $(0, 3, \sqrt{3})$.