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

1. Find all local extrema of the function $f(x,y) = xy\sqrt{1 - x^2 - y^2}$ on the set $M := \{(x,y) : x^2 + y^2 < 1\}$.

2. Find all local extrema of the function $f(x,y,z) = -x^3 + 3xz + 2y - y^2 - 3z^2$.

3. Find approximately the values of the function $f(x,y) = x\sin y - \cos y + \cos(2y)$ at the points $(2 + \varepsilon, \frac{\pi}{2} - \varepsilon)$ for $|\varepsilon|$ small with error of order $o(\varepsilon^2)$.