Q1]...[10 points] Find and classify the critical points of the function

\[ f(x, y) = x^4 + y^4 - 4xy \]
Q2]...[10 points] Use Lagrange multipliers to find the shortest distance from the origin to the surface $xyz^2 = 2$. 

Q3]...[10 points] We are unable to anti-differentiate $e^{-x^2}$. However, we can still evaluate the double integral

$$\int_0^1 \int_y^1 e^{-x^2} \, dx\,dy$$

Show all the steps involved in evaluating this double integral.
Q4. [10 points] Use double integrals to find the area of the portion of the conical surface $3z^2 = x^2 + y^2$ where $1 \leq z \leq 2.$
Q5]...[10 points] Consider the triple integral

\[ \int_0^1 \int_0^{x-z} \int_0^1 f(x, y, z) \, dy \, dx \, dz \]

Sketch the projections of the region of integration on the three coordinate planes.

Rewrite the integral so that the outermost integral is with respect to \( x \) and the innermost integral is with respect to \( z \).
**Bonus**: Find the surface area of the portion of the sphere $x^2 + y^2 + z^2 = 2$ of radius $\sqrt{2}$ which lies above the square with vertices $(\pm 1, \pm 1)$ in the $xy$-plane.