1. Let \( C \) be the curve defined by \( \vec{r}(t) = (\cos t, t, \sin t) \).

   a) Sketch the curve defined above. Label all axes and use arrows to indicate the direction in which \( t \) increases.

   b) Find the parametric equation of the tangent line to the curve at \((-1, \pi, 0)\).

2. Find the limit, if it exists, or show that the limit does not exist.

\[
\lim_{(x,y,z) \to (0,0,0)} \frac{xy + yz^2 + xz^2}{x^2 + y^2 + z^4}
\]

3. Find an equation of the plane tangent to \( \vec{r}(u, v) = (u^2, 2u \sin v, 2u \cos v) \); at \( u = 1, v = 0 \).

4. Use Lagrange Multipliers to find the minimum and maximum values of \( f(x, y, z) = x + y + z \), given that \( x^2 + y^2 + z^2 = 1 \) must hold.

5. Suppose the temperature at a point \((x, y, z)\) in space is given by \( T(x, y, z) = 2xy - z^2 \) degrees Celsius.

   a) If you're standing at the point \((2, -1, 1)\), in which direction should you walk to feel the maximum change in temperature?

   b) What is this maximum rate of change at this point?

   c) What is the rate of change if you instead walk in the direction \((3, 1, 1)\)?
6. Evaluate the iterated integral by setting up a double integral on a domain in the plane and then reversing the order of integration:

\[ \int_0^1 \int_{\sqrt{y}}^1 10y \sin(x^5) \, dx \, dy. \]

7. Find the area of the surface

\[ z = \frac{2}{3} (x^{3/2} + y^{3/2}), \quad 0 \leq x \leq 1, \quad 0 \leq y \leq 1. \]

8. Evaluate

\[ \iiint_D xy^2 \, dV, \]

where \( D \) is the region above \( z = 0 \), below \( z = \sqrt{x^2 + y^2} \) and inside \( x^2 + y^2 = 4 \).

9. Let \( \vec{F}(x, y, z) = (x^2, e^z - y^2, 2yz - 2xz) \).
   
   a) Calculate curl\( \vec{F} \) and div\( \vec{F} \). Is \( \vec{F} \) conservative?
   
   b) Find the flux integral \( \int_S (\vec{F} \cdot \vec{n}) \, dS \), where \( S \) is the sphere of radius 2 centered at the origin and \( \vec{n} \) is the standard outward orientation.

10. \( C \) is the positively oriented square with sides \( x = 0, x = 1, y = 0, y = 1 \). Evaluate the line integral

\[ \int_C e^y \, dx + 2xe^y \, dy. \]