1. Find the velocity, acceleration, and tangential and normal components of acceleration for the trajectory

\[ \vec{R}(t) = (t^2)i + \sin(t^2)j + \cos(t^2)k \]
2. Let $f(x, y) = -2x^3 - y^2 + 2x + 4y$.

(a) Write the equation of the tangent plane to the surface determined by $f$ at the point $(1, 1, 3)$.

(b) Use linear approximation to find $\sqrt{1.08}$
3. Let \( f(x, y) = -(x - 1)^2 + (y - 1)^3 \).

(a) Find the critical points of \( f \) and classify them as maxima, minima, or saddle points.

(b) Find the absolute extrema of \( f \) over the domain \( D = \{(x, y) : 0 \leq x \leq 6, 0 \leq y \leq 6 - x\} \).
4. Let \( f(x, y, z) = -x^3 y^2 z \) and let \( P = (-1, 1, 1) \).

(a) Calculate the derivative of \( f \) in the direction of the vector \( \vec{v} = \vec{i} - 2\vec{j} + 2\vec{k} \).

(b) Find the direction of steepest increase in \( f \) and find the rate of that increase.
5. (a) Evaluate the integral \( \int \int_D x \, dA \) where \( D \) is the triangle with vertices \((0, 0), (3, 0), \) and \((0, 3)\)

(b) Evaluate the integral \( \int_0^1 \int_{3y}^3 \cos x^2 \, dx \, dy \)
6. Evaluate the integral \( \iiint_V (x^2 + y^2 + z^2) \, dV \) where \( V \) is bounded below by \( x^2 + y^2 + z^2 = 2 \) and above by \( z = -\sqrt{x^2 + y^2} \).
7. Let $\vec{F}(x, y) = (x)\vec{i} + (xy)\vec{j}$ and let $C$ be the line segment from $(0, 0)$ to $(2, 3)$. Compute $\int_C \vec{F} \cdot d\vec{r}$. 
8. Let \( \vec{F}(x, y) = (x + y^2 \cos(x))\vec{i} + (2y \sin(x) + y)\vec{j} \) and let \( C \) be the line segment from \((1, 1)\) to \((2, 3)\).

(a) Compute \( \int_C \vec{F} \cdot d\vec{r} \).

(b) Suppose instead that we take the path \( \vec{r}(t) = \langle 1 + t, 1 + 2t^2 \rangle \) from \((1, 1)\) to \((2, 3)\). How does the value of the line integral in (a) change. Explain your answer fully. Do not evaluate the integral.
9. Evaluate the line integral $\int_C (e^x \sin(x^3) - xy)\,dx + (x + y^5 + \sin(e^{xy^2}))\,dy$ where $C$ is the triangle with vertices ((0,0), (1,1), (2,0)) traversed counterclockwise.
10. Calculate the integral $\int \int_S \vec{F} \cdot d\vec{S}$ where $\vec{F} = x\vec{i} + (y + 1)\vec{j}$ and $S$ is the part of the surface $x + y + z = 1$ in the first octant.