1. Consider the three points \( A = (1, 0, 0) \), \( B = (2, 4, 0) \), \( C = (1, 4, 3) \).

   (1) Find the equation of the plane containing these three points.
   (2) Find the area of the triangle \( ABC \).

2. Find the length of the curve \( \mathbf{r}(t) = 2t^2 \mathbf{i} + \cos(2t) \mathbf{j} + \sin(2t) \mathbf{k} \) with \( 0 \leq t \leq 1 \).
3. A particle moves with constant angular speed $\omega$ counterclockwise around a circle with center at the origin in $\mathbb{R}^2$ and radius $R$. The position of the particle at time $t \geq 0$ is $\mathbf{r}(t) = R\cos(\omega t)\mathbf{i} + R\sin(\omega t)\mathbf{j}$.

(1) Find the velocity vector $\mathbf{v}(t)$ and show that $\mathbf{v}(t) \cdot \mathbf{r}(t) = 0$.
(2) Find the speed of the particle.
(3) Find the acceleration vector $\mathbf{a}(t)$ and express its magnitude in terms of the constants $R$ and $\omega$. Describe in words the direction of the acceleration vectors.
4. Find the equation of the tangent plane to the surface $x^2 - 3y^2 + 2z^2 = 3$ at the point $(2, 1, -1)$.

5. Let $f(x, y, z) = xe^{yz}$. At the point $(1, 1, 1)$, in what direction does $f$ increase at the maximum rate and what is this maximum rate of increase?
6. Find the dimensions of the largest rectangular box in the first octant with three faces in the coordinate planes and one vertex in the plane \( x + 2y + 3z = 6 \).
7. Let $f(x, y) = xy^2$. Find the global max and min points and the max and min values of $f$ on the closed disc $D = \{(x, y) \mid x^2 + y^2 \leq 9\}$. 
8. Let $f(x, y)$ be defined on the plane $\mathbb{R}^2$. Suppose, at the point $P = (4, 3)$, $\frac{\partial f}{\partial x}(4, 3) = 2$ and $\frac{\partial f}{\partial y}(4, 3) = -3$. For $r$ and $\theta$ polar coordinates, find the values of $\frac{\partial f}{\partial r}$ and $\frac{\partial f}{\partial \theta}$ at the point $P$. 
9. Let $S$ be the solid bounded by the surface with equation $z = 4$ and the surface with equation $z = x^2 + y^2$. Find the volume of $S$. 
10. Evaluate the integral
\[
\int_{-2}^{2} \int_{-\sqrt{4-y^2}}^{\sqrt{4-y^2}} \int_{\sqrt{x^2+y^2}}^{2} xz \, dz \, dx \, dy.
\]
*Hint: Cylindrical coordinates might be helpful.*
11. Evaluate \( \iiint_B e^{(x^2 + y^2 + z^2)^{3/2}} \, dV \), where \( B \) is the ball in \( \mathbb{R}^3 \) of radius 1 and center at the origin.
12. Let $\gamma$ be the oriented (counterclockwise) boundary of the region $D = \{(x, y) \mid 0 \leq x \leq 1, \ 3 \leq y \leq 6\}$. Let $F$ be the vector field $F(x, y) = (e^{x^2} - y^5 + x)$. Find the value of the line integral 

$$ \int_\gamma F $$
13. Let $F$ be the vector field on $\mathbb{R}^3$ given by $F(x, y, z) = e^{yz} i + xze^{yz} j + xye^{yz} k$. Determine if $F$ is conservative and compute $\text{curl} F$.

14. Let $F$ be the force given at the point $(x, y)$ by $F(x, y) = (e^y + x^2, xe^y - 6y)$. A particle travels along the path $\gamma(t) = (t + t^2, t^4 - t^2)$. Find the work done by the force on the particle. (Distances in feet, magnitude of force in pounds).
15. Let $S$ be the surface with parametrization given by $r(u, v) = (u, v, 9 - u^2 - v^2)$ where $(u, v)$ is from the disc $u^2 + v^2 \leq 9$ in the uv-plane. Find the value of the surface integral $\iint_S \text{curl} F \cdot dS$ for the vector field $F(x, y, z) = ye^{\sin(z)}i + y(x^2 + y^2 - 6)j + (\sin(x) + zy^2)k$.

Hint: Use Stoke’s Theorem. Mind the orientation.
16. Let $B$ be the ball in $\mathbb{R}^3$ with center $(0, 0, 0)$ and radius 3. Let $S$ be the boundary of $B$ with outward normal orientation. Let $F$ be the vector field $F(x, y, z) = (8x + z^3, -2y + xz^2, e^{y^2} + 4z)$. Find the value of the surface integral $\iint_S F$. 