1. (8 points) (a) (4 points) Find the equation for the plane containing the lines $r_1(t) = (1, 2 + t, -1 - 2t)$ and $r_2(t) = (1 + t, 2, -1 - t)$

(b) (2 points) Calculate the area of the parallelogram determined by the two vectors $\mathbf{i} - \mathbf{k}$ and $\mathbf{j} - 2\mathbf{k}$
(c) (2 points) Find the line of intersection between the planes \( x - z = 0 \) and \( y - 2z = 0 \)
2. (10 points) Evaluate the following integrals
   (a) (4 points)
   \[ \iint_{R} e^{2y-3x} \, dA \quad \text{where} \quad R = [1, 2] \times [0, 1] \]
   (b) (6 points)
   \[ \int_{0}^{4} \int_{0}^{\sqrt{3}} \sin(y^3) \, dy \, dx \]
3. (8 points) Let \( f(x, y, z) = x^2 + 2y^2 - z \)

(a) (3 points) In which direction from the point (1,1,0) does \( f \) increase the fastest?

(b) (3 points) What is the rate of change of \( f \) in the direction of the vector \( \mathbf{i} - \mathbf{k} \) at the point (1,1,0)
(c) (2 points) Find the equation of the tangent plane to the surface 
\[ z = x^2 + 2y^2 - 3 \] at \((1,1,0)\)
4. (6 points) Let \( f(u, v) = (v^2, u^2 - v) \) and \( g(x, y, z) = (xz, y^2z) \).

Calculate \( D(f \circ g)(-1, 1, -1) \).
5. (10 points) A particle in space follows a helix-shaped path given by

\[ \mathbf{c}(t) = (\sin(t), \cos(t), t) \]

(a) (3 points) Calculate the velocity vector function \( \mathbf{c}'(t) \)

(b) (2 points) Show that the speed of the particle is constant
(c) (3 points) Find the equation of the tangent line to the path at $t = \pi$

(d) (2 points) If the particle follows the path $c(t)$ until it flies off on a tangent at $t = \pi$, where is the particle at $t = 2\pi$?
6. (10 points) Let $W$ be the region inside the sphere $x^2 + y^2 + z^2 = 4$ and above the plane $z = 0$.

(a) (5 points) Describe $W$ as an elementary region of the form:

$$a \leq x \leq b, \quad \phi_1(x) \leq y \leq \phi_2(x), \quad \gamma_1(x, y) \leq z \leq \gamma_2(x, y)$$

(You need to determine $a$, $b$, $\phi_1(x)$, $\phi_2(x)$, $\gamma_1(x, y)$, $\gamma_1(x, y)$)
(b) (3 points) Rewrite the triple integral
\[ \iiint_{W} 1 \, dV \]
as an iterated integral (you do not have to evaluate it).

(c) (2 points) What does the triple integral in part (b) calculate?