1. Is \( c(t) = (\sin 2t, \cos 2t) \) a flow line of the vector field \( \mathbf{F}(x, y) = (y, -x) \) ?

2. Find the equations of the line tangent to the curve traced out by \( c(t) = (t^3 + 1, 4t^2, 5t) \) at \( t = 2 \).

3. Find the length of the curve traced out by \( c(t) = (2, t - 2\pi, t) \) for \( 2\pi \leq t \leq 4\pi \).

4. Find the volume of the region between \( z = x^2 + y^2 \) and \( z = 32 - x^2 - y^2 \).

5. Find \( \int_0^1 \int_x^1 e^{y^2} \, dy \, dx \).

6. Find the equation of the plane which contains \( (3, 0, 5), (1, 1, 1), \) and \( (2, 3, 4) \). Be sure to check your answer.

7. Find the equations of the line which contains \( (1, 2, 4) \) and \( (7, 8, 9) \). Be sure to check your answer.

8. Find the intersection of \( \frac{x+2}{3} = \frac{y-3}{4} = z + 1 \) and \( x - 2y + 3z + 7 = 0 \). Be sure to check your answer.

9. Find the equation of the plane which is tangent to \( z = x^2 + y^2 \) at \( x = 1 \) and \( y = 2 \).

10. Suppose that \( \mathbf{c}'(t) \) is a path with constant speed. Prove that this path has the property that velocity is always perpendicular to acceleration.

11. Let \( w = f(x, y, z) \). View the rectangular coordinates \( (x, y, z) \) in terms of the spherical coordinates \( (\rho, \phi, \theta) \). Express \( \frac{\partial w}{\partial \theta} \) in terms of \( \frac{\partial w}{\partial x}, \frac{\partial w}{\partial y}, \frac{\partial w}{\partial z}, \rho, \phi, \) and \( \theta \).

12. Consider the function \( f(x, y) = x^2 - y^2 \).
   (a) Graph the level set of value 9 for this function.
   (b) Calculate \( \nabla f|_{(3,0)} \). Graph \( -\frac{1}{10} \nabla f|_{(3,0)} \) on your graph of part (a) starting at \( (3,0) \).
   (c) Calculate \( \nabla f|_{(5,4)} \). Graph \( -\frac{1}{10} \nabla f|_{(5,4)} \) on your graph of part (a) starting at \( (5,4) \).

13. Compute the equation of the plane tangent to the surface parametrized by \( \Phi(u, v) = (u^2 \cos v, u^2 \sin v, u) \) at \( u = 1 \) and \( v = 0 \).

14. Find the area inside \( \frac{x^2}{4} + \frac{y^2}{9} = 1 \).

15. Evaluate \( \iint_S (\nabla \times \mathbf{F}) \cdot d\mathbf{S} \) where \( S \) is the surface \( x^2 + y^2 + 3z^2 = 1, z \leq 0 \), \( \mathbf{F} = \mathbf{r} \).
16. Find \( \int_c (3y + x) \, dx + (8x - 15y) \, dy \), where \( c \) is the path that starts at \((1,0)\); travels along the \( x \)-axis to \((2,0)\); travels in the upper half plane along the circle with center \((0,0)\) and radius 2 to \((-2,0)\); travels along the \( x \)-axis to \((-1,0)\); and travels in the upper half plane along the circle with center \((0,0)\) and radius 1 back to \((1,0)\).

17. Compute \( \int_c \mathbf{F} \cdot \, d\mathbf{s} \), where \( \mathbf{F} = 2z \, \mathbf{i} + x \, \mathbf{j} + 3y \, \mathbf{k} \) and \( c \) is the ellipse that is the intersection of \( z = x \) and the cylinder \( x^2 + y^2 = 4 \).

18. Let \( D^* \) be the parallelogram, in the \( xy \)-plane, with vertices \((0,0)\), \((2,-1)\), \((3,2)\), and \((1,3)\). Let \( D \) be the square

\[
\{(u,v) \mid 0 \leq u \leq 1 \text{ and } 0 \leq v \leq 1\}.
\]

Find a one-to-one function \( T \) from the \( xy \)-plane to the \( uv \)-plane such that \( D \) is the image of \( D^* \) under \( T \).

19. Let \( T(u,v) = (x(u,v), y(u,v)) \) be the mapping defined by

\[
T(u,v) = (u, v(1 + u))\].

Let \( D^* \) be the rectangle

\[
\{(u,v) \mid 0 \leq u \leq 1 \text{ and } 1 \leq v \leq 2\}.
\]

Find \( D = T(D^*) \) and evaluate \( \iint_D (x - y) \, dx \, dy \).

20. What is the distance from \((1,1)\) to \(3x + 2y = 1\)?