1. Sketch a graph of the 2-dimensional vector field \( \vec{F}(x, y) = \frac{y}{2} \hat{i} + 0 \hat{j} = < \frac{y}{2}, 0 > \).

2. A vector field \( \vec{F}(x, y) \) is drawn on the right along with two paths \( C_1 \) and \( C_2 \) and a point \( P \).
   (a) Is \( \text{div} \vec{F}(P) > 0, < 0, \text{or} = 0 \)?
   (b) Is \( \text{curl} \vec{F}(P) = < 0, 0, > ? \)
   (c) Is \( \int_{C_1} \vec{F} \cdot d\vec{r} > 0, < 0, \text{or} = 0 \)?
   (d) Is \( \int_{C_2} \vec{F} \cdot d\vec{r} > 0, < 0, \text{or} = 0 \)?
   (e) Is \( \vec{F} \) a conservative vector field? Why?
   (f) Find a possible formula for \( \vec{F}(x, y) \).

3. Prove that if \( f(x, y, z) \) is any scalar field with continuous second partial derivatives, then \( \text{curl} (\text{grad}(f)) = < 0, 0, > . \)

4. If \( f(x, y, z) = \cos(x) + y^2z \) and \( \vec{F}(x, y, z) = \sin(y) \hat{i} -xz^2 \hat{k} \), find the gradient, divergence, and curl of \( f \text{ and/or} \vec{F} \) whenever it makes sense.

5. Rewrite each of the following expressions in terms of the "del" operator \( \nabla \), and state if each is a vector field, a scalar field, or makes no sense.
   (a) \( \text{div} (\text{curl} f) \), (b) \( \text{grad} (\text{div} F) \), (c) \( \text{div} (\text{grad} F) \), (d) \( (\text{grad} f) \times (\text{curl} F) \),
   (e) \( \text{div} (\text{div} F) \), (f) \( \text{curl} (\text{curl} F) \), (g) \( \text{div} (\text{curl} (\text{grad} f)) \).

6. (a) State the Fundamental Theorem for Line Integrals (FTLI).
   (b) Verify the FTLI for \( \vec{F} = (yz) \hat{i} + (xz) \hat{j} + (xy + \cos(z)) \hat{k} \), if \( C \) the line from \((0,0,0)\) to \((1,1,1)\).

7. (a) State Stokes Theorem. (b) Verify Stokes Theorem for \( \vec{F} = z \hat{i} + x \hat{j} + y \hat{k} \) where \( S \) is the part of the plane \( 2x + 3y + z = 6 \) that lies in the first octant.

8. (a) State the Divergence Thm. (b) Verify the Divergence Thm for \( \vec{F} = x \hat{i} + y \hat{j} + z^2 \hat{k} \) where \( E \) is the cylinder enclosed by the surfaces \( z = 0, z = 5, \) and \( x^2 + y^2 = 9. \)

9. (a) State Green's Theorem.
   (b) If \( C \) is a simple closed counter-clockwise curve in the x-y plane, which of the following line integrals does not give the area enclosed by \( C \)?
   (i) \( \oint_C x \, dy \), (ii) \( \oint_C -y \, dx \); (iii) \( \frac{1}{2} \oint_C x \, dy - y \, dx \); (iv) \( \oint_C 3x \, dy + 2y \, dx \); (v) \( \oint_C y \, dx \).