1. Sketch a sufficient number of vectors to show the following force fields.
   a. \( \mathbf{F} = \langle -x, y \rangle \)
   b. \( \mathbf{F} = \langle -y, x \rangle \)

2. Let \( \mathbf{F} = \langle x^2 + y^2, -2xy \rangle \) be a force field. Evaluate the line integral \( \int_{c} \mathbf{F} \cdot d\mathbf{r} \) to find the work done in moving a particle from the point (0, 0) to (2, 12) by way of the following two paths.
   a. Along the two line segments (0, 0) -> (2, 0) and (2,0) -> (2, 12)
   b. Along the curve \( y = 3x^2 \).
   Conclude whether this line integral is independent of the path.
3. a. Use a test to determine whether the vector field \( F(x,y) = \langle 4x+3y, 3x-6y \rangle \) is a conservative vector field and thus whether the line integral in part (b) is path independent.

b. If this line integral is path independent, find a potential function and evaluate the integral using the potential function. If it is not, use a straight line segment from beginning to end to evaluate it.

\[
\int_{(0,1)}^{(4,3)} (4x+3y)dx + (3x-6y)dy
\]

4. Use Green's theorem to evaluate the circulation integral \( \int_C x^2y^2dx + (x^2 - y^2)dy \) where \( C \) is the square with vertices \((0, 0), (6, 0), (6, 6), \) and \((0, 6)\).
5. Verify Green’s theorem for \[ \int_C xy \, dx + (x + y) \, dy \] where C is the unit circle \( x^2 + y^2 = 1 \).

left side =

right side =
6. Set up the following flux integrals (surface integrals).
   a. \( \mathbf{F} = \langle x, y, z \rangle \) \( S \) is the upper half of the sphere \( x^2 + y^2 + z^2 = 36 \).

   b. \( \mathbf{F} = \langle x, y, z \rangle \) \( S \) is the first octant portion of the plane \( z = -2x - 4y + 4 \).

7. Use the Divergence theorem to find the value of the flux of the vector field \( \mathbf{F} \) below through the closed surface \( S \) where \( \mathbf{F} = \langle y \sin x, y^2 z, x + 3z \rangle \) and the surface \( S \) is the cube bounded by \( x = \pm 1, y = \pm 1, z = \pm 1 \).
8. Verify the Divergence Theorem with the force function \( \mathbf{F}(x, y, z) = \langle 2x, -2y, z^2 \rangle \) where the surface \( S \) is the cylinder \( x^2 + y^2 = 64 \), \( 0 \leq z \leq 8 \).

left side =

right side =
9. Verify Stokes' Theorem with the force function \( \mathbf{F}(x, y, z) = <3z, 4x, 2y> \) where the surface \( S \) is \( z = 9 - x^2 - y^2, \quad z \geq 0 \).

\[ \text{left side} = \]

\[ \text{right side} = \]
10. Use the given transformation to evaluate the integral \( \iint_R (x + y) \, dA \) where R is the square with vertices (0,0), (2,3), (5,1) and (3,-2). The transformation is \( x = 2u + 3v \), \( y = 3u - 2v \).