**Problem 1.** (20 points)

Use Green's Theorem to evaluate the line integral
\[ \int_C (\ln(x) - x^2y)dx + (\ln(y) + xy^2)dy \]
where \( C \) is the triangle with vertices \((0, 0), (1, 0), \) and \((1, 1)\) oriented counter-clockwise.

**Problem 2.** (20 points)

Evaluate the line integral
\[ \int_C x^2y \, ds \]
where \( C \) is the top half of the curve \( x^2 + y^2 = 4. \)
(This is the part of the curve \( x^2 + y^2 = 4 \) that lies in the first and second quadrants.)

**Problem 3.** (20 points)

Let
\[ \mathbf{F} = (x \cos(y) + \sin(z), y \cos(x) - \sin(z), e^{x+y+z}) \]
with domain \( \mathbb{R}^3. \)

Part (a): Compute \( \text{curl} \mathbf{F} \)

Part (b): Compute \( \text{div} \mathbf{F} \)

**Problem 4.** (20 points)

Let
\[ \mathbf{F} = (2xye^{x^2}, e^{x^2}, \cos(z)) \]
with domain \( \mathbb{R}^3. \)

Part (a): Find \( f(x, y, z) \) so that \( \mathbf{F} = \nabla f. \)

Part (b): Compute (by any method)
\[ \int_C \mathbf{F} \cdot \mathbf{T} \, ds = \int_C \mathbf{F} \cdot dr \]
where \( C \) is given by the parameterization \( \mathbf{r}(t) = (t, 2t, \frac{\pi}{2} t), \ t \in [0, 1]. \)

**Problem 5.** (20 points)

Consider the parameterization of the catenoid surface \( S, \) given by:
\[ x = x, \ y = \cosh(x) \cos(\theta), \ z = \cosh(x) \sin(\theta), \ x \in [0, 1], \theta \in [0, 2\pi]. \]

Use this parameterization to evaluate
\[ \iint_S \sinh(x) \, dS. \]