1. (6 points total) *(It’s the simple things...)* Let $C$ be the helix parameterized by $r(t) = (\cos(t), \sin(t), t)$ where $0 \leq t \leq 2\pi$.

(a) (2 points) Let $F(x, y, z)$ be the vector field defined by $F(x, y, z) = (x, y, 0)$. Determine $\int_C F \cdot dr$ when $C$ is oriented in the direction from $(1, 0, 0)$ to $(1, 0, 2\pi)$.

(b) (4 points) Now, let $F(x, y, z)$ be the vector field defined by $F(x, y, z) = (e^{x^2 + y^2}, \ln(x^2 + y^2) - x, 1)$. Determine $\int_C F \cdot dr$ when $C$ is given the opposite orientation.
2. (Deceptive Vector Fields): Let $F(x, y)$ be the vector field defined by

$$F(x, y) = \begin{cases} 
(0, 1) & \text{if } y > 0 \\
(0, 0) & \text{if } y = 0 \\
(0, -1) & \text{if } y < 0 
\end{cases}$$

(a) (3 points) Let $C$ be the unit circle oriented counter-clockwise. Show that $\int_C F \cdot dr = 0$. (You will need to split the integral into two pieces).

(b) (1 point) It turns out this is true for any closed curve in the plane and not just the unit circle. But, this vector field is not conservative. Using whatever method you want, explain why this vector field cannot be conservative.