1. Evaluate the following line integral $\int_C \vec{F} \cdot d\vec{r}$ where

$$\vec{F}(x, y) = \left( \frac{-2y}{x^2 + y^2}, \frac{2x}{x^2 + y^2} \right)$$

where $C$ is the circle $x^2 + y^2 = 1$ in the counterclockwise direction.
2. Are the following vector fields are conservative? Why or why not?

- \( \vec{F}(x, y) = (xy, y) \) defined on \( \mathbb{R}^2 \)
- \( \vec{F}(x, y) = \left( \frac{-2y}{x^2+y^2}, \frac{2x}{x^2+y^2} \right) \) defined on \( \mathbb{R}^2 - (0, 0) \) (Notice this is the vector field from question 1)
- \( \vec{F}(x, y, z) = (1 + yz, 2y + xz, 3z^2 + xy) \) on the ball \( \{ x^2 + y^2 + z^2 \leq 1 \} \).
3. Let $C$ be the boundary of the semiannular region in between the arcs $x^2 + y^2 = 1$ and $x^2 + y^2 = 4$, and lying above the $x$-axis.

If we give $C$ the counterclockwise orientation, then evaluate the line integral $\int_C 2y^2 \, dx + xy \, dy$. 

Cont.
4. Find a potential function for the vector field $\vec{F}(x, y) = (3x^2y + 2y, x^3 + 2x + y)$, and then evaluate the line integral $\int_C \vec{F} \cdot d\vec{r}$, where $C$ is the curve parametrized by $\vec{r}(t) = (\sqrt{t}, t^2)$ where $0 \leq t \leq 4$. 
5. Use Green’s theorem to compute the area of the region enclosed by the curve $\vec{r}(t) = (\sin(\pi t), (t^2 - 2t))$ for $0 \leq t \leq 2$. 

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{triangle_graph.png}
\caption{Diagram of the region enclosed by the curve $\vec{r}(t)$.}
\end{figure}
6. Find the equation of the tangent plane to the surface $x^2 + z^2 + y - 1 = 0$ at the point $(1, -1, -1)$. 
7. Evaluate the following flux integral \[ \iint_S \mathbf{F} \cdot d\mathbf{S} \] where \( \mathbf{F} = (z^2 + y - e^x)\mathbf{i} + 2z\mathbf{j} - y\mathbf{k} \) and \( S \) is the part of the cylinder \( y^2 + z^2 = 4 \) in between the two planes \( x = -1 \) and \( x = 1 \) with outward pointing normal.
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