

1. Let a function $f(x)$ be defined on a closed interval $[0, 1]$ such that

$$f(x) = \begin{cases} 0, & \text{if } x \text{ is irrational,} \\ 1, & \text{if } x \text{ is rational.} \end{cases}$$

Show that the function $f(x)$ has no Riemann integral over $[0, 1]$.

2. Evaluate the indefinite integral $\int \sqrt{x^2 + 1} dx$.

3. Using Stokes' Theorem, evaluate $\int_C \mathbf{F} \cdot d\mathbf{x}$, where $\mathbf{F} = xz\mathbf{i} + xy\mathbf{j} + 3xz\mathbf{k}$ and C is the boundary of the portion of the plane $2x + y + z = 2$ in the first octant, traversed counterclockwise as viewed from above.