**Question 1**  Given a path $c : [a, b] \to \mathbb{R}^n$. $c$ is *regular* at $t_0$ means 

A. the derivative $c'(t_0)$ exists.

B. the derivative $c'(t_0)$ exists and is not zero.

C. the image curve $c([a, b])$ has a tangent vector at $c(t_0)$.

D. $c'(t_0)$ is a unit vector.

*E. both B and C.*
Question 2  Two paths \( c_1 : [0, 2\pi] \rightarrow \mathbb{R}^3 \) and \( c_1 : [0, 2\pi] \rightarrow \mathbb{R}^3 \) are given by

\[
  c_1(t) = (\cos(t), \sin(t), t) \\
  c_2(t) = (\cos(2\pi - t), \sin(2\pi - t), 2\pi - t)
\]

The lengths of the corresponding curves are

*A.* the same since the curves defined by the paths are the same.

*B.* of opposite sign since the paths traverse the curves in opposite directions.

*C.* cannot be computed because the antiderivative of \( \|c_1'(t)\| \) and \( \|c_2'(t)\| \) cannot be computed.

*D.* both B and C

*E.* none of the above
Question 3  Two paths \( c_1 : [0, 2\pi] \rightarrow \mathbb{R}^3 \) and \( c_1 : [0, 2\pi] \rightarrow \mathbb{R}^3 \) are given by

\[
\begin{align*}
c_1(t) &= (\cos(t), \sin(t), t) \\
c_2(t) &= (\cos(2\pi - t), \sin(2\pi - t), 2\pi - t)
\end{align*}
\]

Let \( \mathbf{F}(x, y, z) \) be any \( C^1 \) vector field. The value of the line integrals \( \int_{c_1} \mathbf{F} \cdot ds \) and \( \int_{c_2} \mathbf{F} \cdot ds \) are

A. the same since the curves defined by the paths are the same.

*B. of opposite sign since the paths traverse the curves in opposite directions.

C. cannot be computed because the antiderivative of \( ||c_1'(t)|| \) and \( ||c_2'(t)|| \) cannot be computed.

D. both B and C

E. none of the above
Question 4  Given \( f : \mathbb{R}^n \rightarrow \mathbb{R} \) a \( C^1 \) scalar-valued function and \( c : [a, b] \rightarrow \mathbb{R}^n \) a simple \( C^1 \) path,

A. \( Df(t) = \nabla f (c(t)) \cdot c'(t) \) by the chain rule.

B. \( \int_c \nabla f \cdot ds = \int_a^b \nabla f (c(t)) \cdot c'(t) \, dt. \)

C. The value of \( \int_c \nabla f \cdot ds \) is independent of the path \( c \).

D. \( \int_c \nabla f \cdot ds = f(c(b)) - f(c(a)) \), which depends only on the value of \( f \) at the endpoints \( c(a) \) and \( c(b) \).

*E. All of the above.