12. (From Fall 2010, Exam 1) The Parallelogram Law states that, for any vectors \( \mathbf{u} \) and \( \mathbf{v} \),

\[
|\mathbf{u} + \mathbf{v}|^2 + |\mathbf{u} - \mathbf{v}|^2 = 2|\mathbf{u}|^2 + 2|\mathbf{v}|^2.
\]

(a) Give a geometrical interpretation of the Parallelogram Law.

(b) Prove the Parallelogram Law using vector algebra. [Hint: Use

\[
|\mathbf{u} + \mathbf{v}|^2 = (\mathbf{u} + \mathbf{v}) \cdot (\mathbf{u} + \mathbf{v})
\]

together with the distributive law for the dot product.]

13. Set up but do not evaluate an integral to calculate the length of the parametrized curve

\[
\mathbf{r}(t) = (t^2, e^{3t}, \cos(4t)), \quad 0 \leq t \leq \pi.
\]

That is, find numbers \( a \) and \( b \) and a function \( F \) so that the length of the curve is given by

\[
\int_a^b F(t) \, dt.
\]