(10) I. Give a coordinate equation for the plane through the point (3, 4, 5) which is perpendicular to the vector \( \mathbf{n} = \mathbf{i} + 3\mathbf{j} + 2\mathbf{k} \).

(10) II. Suppose \( \mathbf{a} \) is a vector with tail at the point (3, 1, -2) and head at the point (5, 4, 3). Give a unit vector that is perpendicular to \( \mathbf{a} \).
(36) III. If \( \mathbf{a} = \mathbf{i} - \mathbf{j} + \mathbf{k} \) and \( \mathbf{b} = \mathbf{i} + 3\mathbf{j} + 5\mathbf{k} \) then

A. \( \text{comp}_b(a) = \) \\
B. \( \text{proj}_b(a) = \) \\
C. \( \mathbf{a} \times \mathbf{b} = \) \\
D. \( \mathbf{b} \times \mathbf{b} = \) \\
E. \( \mathbf{b} \times \mathbf{a} = \) \\
F. A parametrization for the line through the point \((1, 1, 1)\) and parallel to \( \mathbf{a} \) is:
G. A parametrization for the plane through the point \((1, 1, 1)\) and parallel to \(\mathbf{a}\) and \(\mathbf{b}\) is:

H. The cosine of the angle between \(\mathbf{a}\) and \(\mathbf{b}\) is:

I. \[|\mathbf{a}| = \]

(10) IV. Calculate the integral:

\[\int \left( \frac{1}{t} \mathbf{i} + (\cos t) \mathbf{j} + \sqrt{t} \mathbf{k} \right) dt\]
(16) V. Give examples of:

A. Two unit vectors in \( \mathbb{R}^3 \) that are perpendicular.

B. Equations of two distinct parallel planes in \( \mathbb{R}^3 \).

C. Parametric equations of two distinct parallel lines in \( \mathbb{R}^3 \).

D. A path in \( \mathbb{R}^3 \), i.e. a function \( f : \mathbb{R} \to \mathbb{R}^3 \), which crosses itself, i.e. \( f(a) = f(b) \) for some numbers \( a \) and \( b \).
VI. Suppose $A = \begin{bmatrix} 6 & 4 \\ 6 & 3 \end{bmatrix}$ and $T : \mathbb{R}^2 \to \mathbb{R}^2$ is a linear transformation with the formula: $T(x) = Ax$.

If $P$ is the parallelogram in $\mathbb{R}^2$ with vertices $(1, 2), (4, -1), (3, 6), \text{ and } (6, 3)$,

A) What is the area of $P$?

B) What is the area of $T(P)$?

VII. Given the quadratic form $r(x, y, z) = x^2 - 2xy + 3y^2 + 2z^2$

A. Express $r(x, y, z)$ in the form $(x, y, z)^T S \begin{bmatrix} x \\ y \\ z \end{bmatrix}$, where $S$ is a symmetric matrix.

B. Is $r(x, y, z)$ positive definite, negative definite, or indefinite? Explain why.