(10) I. Give a parametric equation of the line segment connecting the point \((1, 2, 3)\) and the point \((2, 3, 4)\). This is a line segment of finite length, so be sure to put the proper limits on the parameter.

(10) II. Give a coordinate equation for the plane containing the point \((1, 2, 5)\) which is perpendicular to the cross product of the vectors \(v_1 = \mathbf{i} + \mathbf{j} + \mathbf{k}\) and \(v_2 = \mathbf{i}\).
(20) III. Let the function $f : \mathbb{R}^2 \to \mathbb{R}$ be given by the rule $f(x, y) = \sqrt{x^2 + y^2}$.

A. Sketch a graph or describe the graph of $z = f(x, y)$ in words, mentioning what the surface looks like near the point $(0, 0, 0)$.

B. $\frac{\partial f}{\partial x}(x, y) =$

C. $\frac{\partial f}{\partial y}(x, y) =$

D. Explain why $\frac{\partial f}{\partial x}(0,0)$ and $\frac{\partial f}{\partial y}(0,0)$ are not defined.

E. Sketch the graph of the intersection of the graph of $f$ with the plane $x = 0$.

F. Show that $\lim_{(x, y) \to (0,0)} \frac{\partial f}{\partial y}(x, y)$ does not exist by computing the limit from both directions along the line $x = 0$. 
(16) IV. The plane $P$ has equation $x + y + z = 0$.

A. Give a unit vector that is perpendicular to $P$.

B. Give a point that is in $P$.

C. Give the components of two non-parallel vectors which are perpendicular to the normal to $P$.

D. Give a parametrization of $P$. 
(10) V. The points (1, 1), (2, 3), (5, 4), and (6, 6) are the four corners of a parallelogram in \( \mathbb{R}^2 \).
What is the area of that parallelogram?

(15) VI. Give examples of:

A. The equation of any line in \( \mathbb{R}^4 \).

B. Two orthogonal vectors in \( \mathbb{R}^5 \).

C. A negative definite quadratic form in three variables.
(10) VII. Suppose \( A = \begin{bmatrix} 1 & -1 \\ 0 & 1 \end{bmatrix} \) and \( T : \mathbb{R}^2 \to \mathbb{R}^2 \) is a linear transformation with the formula \( T(x) = Ax \). Suppose \( a = 3i + 2j \).

A) \( T^{-1}(a) = \)

B) \( T(T^{-1}(a)) = \)

(9) VIII. The graphs of the level surfaces for the function \( f : \mathbb{R}^3 \to \mathbb{R} \) with rule \( f(x, y, z) = x^2 + y^2 - z \) are in \( \mathbb{R}^3 \). Try as best you can to describe in words or pictures the level surfaces for \( c = -1 \), \( c = 0 \), and \( c = 1 \).