Recall the following definitions:

(i) A **vector parametrization** of the line through the endpoint of the vector \( \mathbf{a} \) in the direction of the vector \( \mathbf{b} \) is given by \( \mathbf{r}(t) = \mathbf{a} + t\mathbf{b} \), where \( t \in \mathbb{R} \).

(ii) A **scalar parametrization** of the line in (i) is

\[
\begin{align*}
x &= a_1 + tb_1 \\
y &= a_2 + tb_2 \\
z &= a_3 + tb_3
\end{align*}
\]

where \( \mathbf{a} = (a_1, a_2, a_3) \) and \( \mathbf{b} = (b_1, b_2, b_3) \).

(iii) A **level set equation** of a plane is an equation of the form

\[
ax + by + cz = d,
\]

where \( a, b, c, d \) are real numbers.

(iv) A **parametrization** of a plane through the endpoint of the vector \( \mathbf{u} \) that contains the vectors \( \mathbf{v} \) and \( \mathbf{w} \) is of the form \( \mathbf{r}(s, t) = \mathbf{u} + s\mathbf{v} + t\mathbf{w} \), where \( s, t \in \mathbb{R} \).

For each problem start by drawing a schematic diagram that illustrates the geometrical relationships between the various points, lines, vectors, planes in the problem. Use your diagram to help you set up equations that will help you solve the problem.

1. Find a vector parametrization for the line passing through the points \((1, 2, 3)\) and \((9, 8, 7)\).

2. Find the level set equation and a parametrization of the plane through the point \((1, 2, 3)\) with normal vector \((4, 5, 6)\).

3. Find the level set equation of the plane through the point \((1, 2, 3)\) parallel to the plane \(3x - 5y + 7z = 8\).

4. Find the level set equation and a parametrization of the plane through the points \((1, 0, -1)\), \((3, 3, 2)\), and \((4, 5, -1)\).

5. Find a parametrization of the plane that contains both the point \((2, 4, 6)\) and the line \(x = 7 - 3t, y = 3 + 4t, z = 5 + 2t\).
6 Does the line \( x = 3 + 2t, y = 6 - 5t, z = 2 + 3t \) intersect the plane \( 3x + 2y - 4z = 1 \)?

7 Find the equation of the plane that contains the point \((1, 2, 3)\) and is perpendicular to the line \( \mathbf{r}(t) = (4 - t, 5 + 6t, 7 - 2t) \).

8 How many planes contain the point \( \mathbf{p} = (1, 2, 3) \) and are parallel to the line \( L \) with parametrization \( \mathbf{r}(t) = (4 - t, 5 + 6t, 7 - 2t) \)? Find an equation for one such plane. How many planes contain \( \mathbf{p} \) and also contain \( L \)? Justify your answers.

9 Find a parametrization of the line through the point \((1, 2, -4)\) that is perpendicular to the plane \( x + 2y + 4z = 8 \).

10 Is the line \( \mathbf{r}(t) = (1 - 2t, 2 + 5t, -3t) \) parallel to the plane \( 2x + y - z = 8 \)?