1. An elliptic hyperboloid of one sheet is **doubly ruled**: for each point on the surface, there are two lines through the point lying entirely in the surface. We will show that the particular surface $S : x^2 + y^2 - z^2 = 1$ has this property. It follows that the elliptic hyperboloid $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} - \dfrac{z^2}{c^2} = 1$ is also doubly ruled as it differs from S by an affine transformation.

   (a) Write the coordinates for every point P on the surface S lying in the plane $z = 0$ in a closed form.

   (b) Find the two lines through P that lie on S. Write the equations of the lines in the form $l_{P,1}, l_{P,2} : \vec{r} = P + t\vec{v}_i$.

   (c) For all points R on S with $z \neq 0$, show that there are points P, Q on S lying in the xy-plane such that $l_{P,1}$ and $l_{Q,2}$ intersect at R.

2. Find the equation of the plane passing through the points $(1, 0, 3)$, $(0, 4, 2)$, and $(1, 1, 1)$.

3. Find the point at which the line $x = -2t + 5, y = 3t - 5, 4t - 6$ intersects the plane $3x + 2y - 4z = -3$.

4. Find the distance of the point $P(0, 0, 0)$ from the plane $x - 3y + 2z = 4$.

5. Identify the quadric surfaces:

   (a) $9x - 81y^2 - \dfrac{z^2}{4} = 0$

   (b) $x^2 - 2x + 4y^2 + 8y + 4z^2 + 16z = -21$

   (c) $y^2 = 4$

   (d) $x^2 + 4y^2 - 4z^2 - 6x - 16y - 16z + 5 = 0$

   (e) $xy + z = 1$