1. \( a = \langle 1, 3, -3 \rangle, b = \langle 2, 2, 4 \rangle. \)
   i. Find the component of \( b \) in the direction of \( a \).
   ii. Determine the orthogonal projection of \( b \) onto \( a \).
2. Express \( b = \langle -4, 1 - 2 \rangle \) as \( b = b_1 + b_2 \) where \( b_1 \) is parallel to \( a \) and \( b_2 \) is orthogonal to \( a \) and \( a = \langle 1, 3, -3 \rangle \).
3. Find the equation of a plane that contains the points \((1, -1, 4), (0, 2, 3) \) and \((2, 1, 0)\).
4. Find the equation of a plane that contains the point \((1, 0, -1)\) and is parallel to the plane \(x + y - z = 4\).
5. Find the equation of a line that satisfies the condition that it passes through the point \((1, 2, 3)\) and is parallel to the line whose parametric equations \(x = t + 1, y = -t, z = t - 4\).

V. Sketch the following:

1. The surface \( x^2 - y^2 - z^2 - 4x - 4y = 0 \) (hint: complete the square).
   Partial credit will be given for the sketch in each of the planes.
2. For \( \mathbf{r}(t) = (t, \sqrt{2} \cos(t), \sqrt{2} \sin(t)) \).
   a. Sketch the curve.
   b. Find the arc length from \( t = 0 \) to \( t = \pi \)
   c. Treating \( \mathbf{r}(t) \) as a particle motion, find \( \mathbf{v}(t) \) and \( \mathbf{a}(t) \)
1. Sketch the region bounded by the cone \( z = \sqrt{x^2 + y^2} \) and the plane \( z = 2 \).
2. Sketch the region bounded by the cone whose angle in spherical coordinates is given by \( \phi = \frac{\pi}{4} \) and a sphere of radius 2.
3. Sketch \( x^2 + y^2 + z - 9 = 0 \)

IV. Find the equation of the Plane which satisfy the following:

1. A plane through the points \((0, 0, 0), (1, 1, 1), (1, 2, 3)\).
2. A plane through the point \((0, 1, 2)\) and containing the line \(x = t, 2y = t, 3z = t\).
3. Find the point where the line \(x = t + 1, y = 2t, z = 3t\) and the plane \( x + y + z = 1 \) intersect.
I. Answer the following:

1a.) What is the area of the triangle whose vertices are: \( v_1 = (0, 0, 1), \) 
\( v_2 = (0, 2, 0) \) and \( v_3 = (3, 0, 0). \)

1b. Find a parallelogram where 3 vertices are: \( v_1 = (0, 0, 1), v_2 = (0, 2, 0), v_3 = (3, 0, 0). \)

2.) Assume \( V \) satisfies \( A \times V = B \) where \( A \) is a unit vector and \( B \bot A \)
Using the fact that \( Ax(BxC) = (A \cdot C)B - (A \cdot B)C \)
Simplify the following:
   i.) \( V = B + (A \times B). \)
   ii.) \( V = B - (A \times B). \)
   iii.) \( V = (A \times B). \)
   iv.) \( V = A + (A \times B). \)
   v.) \( V = A - (A \times B). \)

3.) Let \( L \) be the line in \( \mathbb{R}^3 \) that passes through the points \( P = (-1, -2, 4) \) and \( Q = (4, 2, 1). \) At what point (if any) does \( L \) intersect the plane \( x + y + 2z = 11? \)

4.) Let \( P = (1, -1, 1) \) and \( Q = (-3, 3, 3). \) Find the point \( R \) such that:
   i.) \( R \) is half way between \( P \) and \( Q. \)
   ii.) \( R \) three fourths of the distance between them.

5.) If \( L \) is the line through \( A = (3, 2, 1) \) and parallel to the vector \( v = <-2, 1, 3> \), what’s the equation of the plane that contains \( L \) and the point \( B = (-2, 3, 1). \)

6.) Find the distance from the origin to the plane \( x + 2y + 2z = 6. \)

7a.) Find the equation of the surface traced by \( z = f(x) \) in the x-z plane and revolved around the x = axis.

7b.) Let \( C \) be the circle in the \( y - z \) plane whose equation is \( (y - 3)^2 + z^2 = 1. \) If \( C \) is revolved around the \( z \) axis, the surface generated is a torus”doughnut”. Find its equation.

8.) The plane \( y = 1 \) slices the surface \( z = \arctan(\frac{x+y}{1-x-y}) \) in a curve \( C. \) Find the slope of the tangent line to \( C \) at the point where \( x = 2. \)

9.) Graph in cylindrical coordinates the surface \( z = r^2 \cos(2\theta). \)

10.)
   i.) Graph the surface \( z = 8xy. \)
11.) Graph the solid in the first octant bounded by the plane $x + 2y + z = 4$.
12.) Graph the solid inside the paraboloid $z = (x^2 + y^2)$ and below the plane $z = 1$. 