1. (20 points)
   a. Find a value of the constant $c$ so that the vectors $\vec{u} = \langle -2,-3,4 \rangle$ and $\vec{v} = \langle 6,9,c \rangle$ are parallel.

   b. Find the angle between the vectors $\vec{a} = \langle 1,-1,3 \rangle$ and $\vec{b} = \langle -1,2,-2 \rangle$.

   c. Find the work done by the constant force $\vec{F} = \langle -1,2,4 \rangle$ in moving an object from the point $(2,3,-2)$ to the point $(-1,-2,3)$.

   d. Find a value of the constant $c$ so that the vectors $\vec{u} = \langle -2,-3,4 \rangle$ and $\vec{v} = \langle 1,3,c \rangle$ are perpendicular.

2. (14 points)
   a Find an equation of the plane passing through the points $(1,0,3)$, $(2,1,4)$, and $(-1,-1,2)$.

   b Find a parametric representation of the line that passes through the point $(2,-1,7)$ and is parallel to the line
   $$\vec{r}(t) = \langle -2 + 4t, 1 + 3t, 4 - 3t \rangle, \quad -\infty < t < \infty.$$
3. (13 points) Given the vectors \( \vec{u} = <3, -2, 4> \) and \( \vec{v} = <-1, 2, 1> \), find the component of \( \vec{u} \) in the direction of \( \vec{v} \). Also find the vector projection of \( \vec{u} \) on \( \vec{v} \).

4. (25 points)
   a. Find the area of the triangle with vertices \( P = (2, 1, 3) \), \( Q = (1, -2, -3) \), \( R = (-2, 3, 4) \).

   b. Find the Taylor polynomial of degree 2 for \( f(x) = \tan(2x) \) about \( x = \frac{\pi}{8} \).

   c. Graph the surface \( x^2 + (z - 2)^2 = 4 \) in \( \mathbb{R}^3 \).

   d. Graph the surface \( -x^2 - y^2 + z^2 = 1 \) in \( \mathbb{R}^3 \).

   e. Find the distance from the point \( (1, 3, 2) \) to the plane \( z = 3x + 4y + 5 \).
5. (13 points) Given $\vec{r}(t) = < 2 \sin t, -2 \cos t, 3t >$, $t \geq 0$ is the position vector of an object at time $t$. Find the velocity, acceleration, and speed of the object at time $t = \frac{\pi}{4}$.

6. (15 points)
   a Find the volume of the tetrahedron with vertices $P = (2, 1, 3)$, $Q = (1, 0, -1)$, $R = (3, 1, 2)$, $S = (4, 1, 2)$.

   b Graph the curve $C: x(t) = 6 - t^2$, $y(t) = \frac{t}{2}$, $-2 \leq t \leq 4$.

   c Find a parametrization of the ellipse $\frac{x^2}{4} + \frac{y^2}{9} = 1$, where you go around the ellipse one time in the clockwise direction.