

1. Let $\vec{u} = \langle 1, 1, 1 \rangle$ and $\vec{v} = -3\vec{i} + 2\vec{j} + 4\vec{k}$. Compute the following:

- (a) $\vec{u} \cdot \vec{v}$
- (b) $\vec{u} \times \vec{v}$
- (c) $\|\vec{u}\|$ and $\|\vec{v}\|$
- (d) Find the projection of \vec{u} onto \vec{v} .
- (e) Compute the angle between \vec{u} and \vec{v}

2. How close does the line with direction vector $\vec{i} - \vec{j} + \vec{k}$ through the point $(4, 7, -2)$ come to the origin?

3. (a) Convert the point $(5/2, 4/3, -3/2)$ from rectangular to cylindrical and spherical coordinates.

(b) Convert the point $(5, 3\pi/4, -5)$ from cylindrical to rectangular and spherical coordinates.

(c) Convert the point $(4, 2\pi/3, \pi/4)$ from spherical to rectangular and cylindrical coordinates.

4. The lines given by

$$\vec{L}_1(t) = (t+1)\vec{i} + (t-1)\vec{j} + t\vec{k}$$

$$\vec{L}_2(t) = 2\vec{i} - 3t\vec{j} + (t+1)\vec{k}$$

lie in a plane. Write an equation for this plane.

5. Write the equation of a sphere with center $(4, -4, 12)$ and tangent to the plane $x = y + 1$.

6. Graph the surfaces defined by the following equations.

(a) $4x^2 + 9y^2 - 36z = 36$

(b) $3x^2 - y^2 - z = 0$ (you might try setting $z = 1$)

(c) $x^2 + z^2 - e^{2y} = 0$

(d) $\theta = \frac{\pi}{3}$

7. Plot the images of the following vector valued functions.

(a) $\vec{r}(t) = 4 \cos t \vec{i} + 4 \sin t \vec{j} + t \vec{k}$

(b) $\vec{r}(t) = -2t \vec{i} + t \vec{j} + 3t \vec{k}$

(c) $\vec{r}(t) = \cos(2t)\vec{i} + \sin t\vec{j} + t\vec{k}$

(d) $\vec{r}(t) = t\vec{i} + \ln t\vec{j}$

8. The surfaces given by

$$x^2 - 5y^2 + 2z^2 + 2y = 3$$

$$3x^2 - 15y^2 + 6z^2 + 4z = 7$$

intersect at a curve. Does this curve lie in a plane? Which plane?

9. A piece of driftwood floats in the ocean. It is carried by a current flowing due north at a speed of 1.8 km/hr . Just as the driftwood passes by a stationary buoy, a strong breeze begins blowing northwest accelerating the driftwood at a rate of 0.25 m/s^2 . Find a vector valued function describing the location of the driftwood t seconds after it passes the buoy.

10. Find the unit tangent \vec{T} and unit normal \vec{N} at $t = 0$ for the curve defined by the vector valued function

$$\vec{r}(t) = 5t\vec{i} + e^t\vec{j} + e^{-t}\vec{k}.$$

11. Find the arc length of the curve given by $\vec{r}(t) = t^3\vec{i} + \cos(6t^2)\vec{j} + \sin(6t^2)\vec{k}$ between $\vec{r}(0)$ and $\vec{r}(3)$.

12. Find and plot the domain of the function

$$f(x, y) = \frac{\sqrt{x-3}}{x^2 - y}$$

13. Consider the following functions

(a) $f(x, y) = \sqrt{x^2 + y^2}$

(b) $f(x, y) = x^2 + y^2 - 3$

(c) $f(x, y) = \arctan x$

(d) $f(x, y) = -y^2e^{-x}$

Graph them and compute $f_x(x, y)$, $f_y(x, y)$, $f_{xy}(x, y)$. Where are these functions differentiable?