1. Given: \( \mathbf{u} = \langle 4, -1, -5 \rangle, \mathbf{v} = \langle 3, 1, -2 \rangle, \mathbf{w} = \langle 2, -3, 6 \rangle \)

Find:

a. \( \mathbf{u} \cdot (2\mathbf{v} - 3\mathbf{w}) \)

b. A unit vector in the opposite direction of \( \mathbf{w} \).

c. \( \mathbf{v} \times \mathbf{w} \)

d. The angle (in radians) formed by \( \mathbf{u} \) and \( \mathbf{v} \).

e. The volume of the parallelepiped formed by the vectors \( \mathbf{u}, \mathbf{v}, \) and \( \mathbf{w} \).

2. Find the parametric equations of the line of intersection of the planes

\[ 3x + y - 5z = 6 \quad \text{and} \quad x - 2y - 4z = 9 \]

3. Given the points \( (2, -1, -1), (1, 0, 1), \) and \( (3, 2, 2) \), find the equation of the plane that passes through these points. Write your answer in the form \( ax + by + cz = d \).

4. Evaluate:

\[
\int_0^\pi \left( \cos(3t)\mathbf{i} + t \cos t\mathbf{j} + \cos^4 t \sin t\mathbf{k} \right) dt
\]

5. Given the vector function \( \mathbf{r}(t) = \langle 4 \sin(2t), 3t, 4 \cos(2t) \rangle \)

a. Find the length of the curve from \( t = 0 \) to \( t = \frac{\pi}{3} \).

b. Find the curvature \( \kappa \).

6. Given \( f(x, y) = \ln(5x + y^3) - \tan(x^3 + y) \), find:

a. \( f_x(x, y) \)

b. \( f_{xy}(x, y) \)

c. \( f_{yy}(x, y) \)

7. Given the function \( z = f(x, y) = 2xy^3 - x^2y \)

a. Find the equation of the tangent plane, in the form \( ax + by + cz = d \), to the surface at the point \( (3, 2, 30) \).

b. If \( (x, y) \) changes from \( (3, 2) \) to \( (3.05, 1.9) \), find the values of \( \Delta z \) and \( dz \).
1. a. \( <4, -1, -5> \cdot <0, 11, -22> = 99 \)
   b. \( < -\frac{2}{7}, \frac{3}{7}, -\frac{6}{7} > \)
   c. \( <0, -22, -11> \)
   d. \( \cos^{-1}\left(\frac{\sqrt{3}}{2}\right) = \frac{\pi}{6} \)
   e. \( V = |\mathbf{u} \cdot (\mathbf{v} \times \mathbf{w})| = 77 \)

2. \( x = 3 + 2t \)
   \( y = -3 - t \) (there are many possible "initial" points)
   \( z = 0 + t \)

3. \( 3x - 5y + 4z = 7 \)

4. \( -\frac{1}{3}\mathbf{i} + \left(\frac{\pi}{2} - 1\right)\mathbf{j} + \frac{1}{5}\mathbf{k} \)

5. a. \( l = \int_0^\pi \left(\sqrt{73}\right) \, dt = \frac{\pi\sqrt{73}}{3} \)
   b. \( \kappa = \frac{|\mathbf{r}'(t) \times \mathbf{r}''(t)|}{|\mathbf{r}'(t)|^3} = \frac{|\mathbf{T}'(t)|}{|\mathbf{r}'(t)|} = \frac{16}{73} \)

6. a. \( \frac{5}{5x+y^3} - 3x^2\sec^2(x^3+y) \)
   b. \( \frac{-15y^2}{(5x+y^3)^2} - 6x^2\sec^2(x^3+y)\tan(x^3+y) \)
   c. \( \frac{30xy-3y^4}{(5x+y^3)^2} - 2\sec^2(x^3+y)\tan(x^3+y) \)

7. a. \( 4x + 63y - z = 108 \)
   b. \( \Delta z = f(3.05, 1.9) - f(3, 2) = -5.83485 \)
   c. \( dz = f_x(3, 2) \, dx + f_y(3, 2) \, dy = -6.1 \)