1. Given the points \( A = (5, 3, 0), B = (6, 1, 1), \) and \( C = (1, 5, 2) \), find:

   a. parametric equations for the line that passes through \( C \) and is parallel to the line that passes through \( A \) and \( B \).
   b. the angle \( \angle BAC \).
   c. the equation of the plane (in the form \( ax + by + cz = d \) ) through these three points.

2. Given the equation \( z^2 = 36 - 4x + 9y^2 \):

   a. Classify this quadric surface.
   b. Find the equation of the tangent plane to this surface at the point \( (5, 1, -5) \). Express your answer in the form \( ax + by + cz = d \).

3. Find \( r(t) \) if \( r'(t) = (t)i + (e^{2t})j + (te^t)k \) and \( r(0) = i + 2j + 4k \).

4. Given the curve defined by \( r(t) = \langle -2t + 3, t^2 - 1, \frac{1}{3}t^3 + 2 \rangle \), find:

   a. the vector equation for the line \( L(t) \) tangent to this curve when \( t = 1 \).
   b. the length of this curve between the points \( \left(1, 0, \frac{7}{3}\right) \) and \( (-6, 8, 11) \).
   c. the curvature \( \kappa \) at the point when \( t = 1 \).

5. Given \( f(x, y, z) = 6x^3y + 4x^2y^3z - 5xz^2 \), find:

   a. \( f_{xz}(x, y, z) \)  
   b. \( \nabla f(1, 2, -1) \) 
   c. the directional derivative of \( f(x, y, z) \) at \( (1, 2, -1) \) in the direction of the point \( (5, 1, 7) \).
6. A cardboard box without a top needs to have a volume of 4000 cubic centimeters. Find the dimensions of the box that minimizes the amount of cardboard used. List the dimensions in the following order: length, width, height.

7. Evaluate by reversing the order of integration:

$$\int_0^8 \int_{\sqrt[3]{x}}^2 e^{y^3} dy \, dx$$

8. Switch to polar coordinates to evaluate:

$$\int_0^3 \int_y^{\sqrt{18-y^2}} e^{x^2+y^2} \, dx \, dy$$

9. Find the volume of the solid in the first octant bounded by the cylinder \( y = x^2 \), the plane \( 2x + 4y + z = 20 \), and the plane \( x = 0 \).

10. Use a triple integral to find the volume of the 'spherical cap' inside the sphere \( x^2 + y^2 + z^2 = 16 \) that is above the plane \( z = 2 \).
1. a. \( y = 5 - 2t \)
   
   b. \( \cos^{-1}\left(-\frac{1}{2}\right) = \frac{2\pi}{3} \)
   
   c. \( x + y + z = 8 \)

2. a. hyperbolic paraboloid
   
   b. \( 2x - 9y - 5z = 26 \)

3. \( \mathbf{r}(t) = \left(\frac{1}{2}t^2 + 1\right)\mathbf{i} + \left(\frac{1}{2}e^{2t} + \frac{3}{2}\right)\mathbf{j} + (t e^t - e^t + 5)\mathbf{k} \)

4. a. \( \mathbf{L}(t) = <1 - 2t, 2t, \frac{7}{3} + t> \)
   
   b. \( \frac{38}{3} \)
   
   c. \( \frac{2}{9} \)

5. a. \( 8xy^3 - 10z \)
   
   b. \( <-33, -42, 42> \)
   
   c. \( \frac{82}{3} \)

6. Minimize : \( A = lw + 2lh + 2wh \) subject to \( V = lwh = 4000 \)

   Setting \( \nabla A = \lambda \nabla V \) yields \( l = 20 \text{ cm}, w = 20 \text{ cm}, h = 10 \text{ cm} \)

7. \( \int_0^2 \int_0^y e^{y^3} dx dy = \ldots = \frac{1}{4}(e^{16} - 1) \)

8. \( \int_0^{\frac{\pi}{4}} \int_0^{3\sqrt{2}} e^{x^2} r dr d\theta = \ldots = \frac{\pi}{8}(e^{18} - 1) \)

9. \( V = \int_0^2 \int_{x^2}^{5-\frac{1}{2}x} (20 - 2x - 4y) dy dx = \ldots = \frac{652}{15} \)

10. Cylindrical coordinates yield simplest triple integral :

    \( V = \int_0^{2\pi} \int_0^{2\sqrt{3}} \int_2^{\sqrt{16-r^2}} r dz dr d\theta = \ldots = \frac{40\pi}{3} \)