1. (a) Find the point where the line \( y = 2 - 3t \quad -\infty < t < \infty \) meets the plane \( 2x + y + z = 4 \).

(b) Find equation of the plane containing the intersecting lines

\[
\begin{align*}
x &= 3 + t \\
y &= 4 - 3t \\
z &= 1 + 2t
\end{align*}
\quad \text{and} \quad
\begin{align*}
x &= 2 + 2s \\
y &= 4 + s \\
z &= 1 - 2s
\end{align*}
\]
2. Find the length of the curve given by the vector valued function \( \mathbf{r}(t) = e^{t} \mathbf{i} - \sqrt{2} t \mathbf{j} + e^{t} \mathbf{k}, \)
\( 0 \leq t \leq \ln 3. \)

3. A particle moves with velocity vector \( \mathbf{v}(t) = e^{t} \mathbf{i} + \sin t \mathbf{j} + 2t \mathbf{k} \) at time \( t. \) At time \( t = 0 \) its position vector is \( \mathbf{r}(0) = 2 \mathbf{i} + 3 \mathbf{j} - \mathbf{k}. \) Find its position vector \( \mathbf{r}(t) \) at time \( t. \)
4. Compute the following limits:

(a) \[ \lim_{(x,y) \to (0,0)} \frac{3xy}{x^2 + 2y^2} \]

(b) \[ \lim_{(x,y) \to (2,3)} \frac{xy - 2y + 3x - 6}{xy - 2y} \]

5. (a) Find the linearization of the function \( f(x,y) = e^{3y-x} \) at the point \( P(3,1) \).

(b) Find the direction in which the function \( f(x,y,z) = 2xy^2 + xy^2 \) increases most rapidly at the point \( Q(3,-1,1) \) and find that rate of increase.
6. Find and identify the local maxima, local minima and saddle points of the function 
\[ f(x, y) = 2x^2 + y^2 + xy^2 + 3. \]

7. Find the maximum and minimum values of \( f(x, y) = xy \) on \( 2x^2 + y^2 = 4 \).
8. Write down an integral, complete with limits, that computes the area of the part of the surface 
\( z = 2x^3 + y^2 \) the lies above the triangle with vertices (0,0), (0,2) and (2,2). (Do not try to evaluate 
the integral.)

9. Let \( I = \int_0^1 \int_0^{\sqrt{1-y^2}} (1 + x^2 + y^2) \, dy \, dx \).

(a) Sketch the region of integration for \( I \).

(b) Write \( I \) using polar coordinates and evaluate it.
10. Evaluate \( \iiint_E xy \, dV \) if \( E \) is the region in the first octant bounded by the coordinate planes as well as the planes \( x = 3, y = 1 \) and \( z = 2 + x + y \).

11. Find the mass of the hemisphere \( 0 \leq z \leq \sqrt{4 - x^2 - y^2} \) if the density function is given by \( \rho(x,y,z) = \sqrt{x^2 + y^2 + z^2} \).
12. Let \( I = \iint_D 6y \, dA \), where \( D \) is the region bounded by the four lines \( x + 2y = 1 \), \( x + 2y = 3 \), \( x - y = 0 \) and \( x - y = 1 \).

(a) Let \( u = x + 2y \) and \( v = x - y \). Find \( x \) and \( y \) in terms of \( u \) and \( v \).

(b) Compute the Jacobian determinant \( \frac{\partial(x, y)}{\partial(u, v)} \).

(c) Evaluate \( I \) by taking an integral in the \( uv \)-plane.