Use the papers provided by the department. Write clearly with short and concise motivations. Illustrate with a figure when necessary.

1. Determine all local extreme points for the function \( f(x, y) = x^3 + 3xy^2 + 2x^2 - y^2 \).

2. Prove that the equation
\[
 x^3 + y^3 + z^3 - xyz = 26
\]
defines \( z = z(x, y) \) as a \( C^1 \)-smooth function in a neighbourhood of the point \((1, 1, 3)\). Also show that the function \( z(x, y) \) has a critical point at \((x, y) = (1, 1)\).

3. Calculate the triple integral
\[
 \iiint_D (z^2 + z) \, dxdydz
\]
over the domain \( D : x^2 + y^2 + z^2 \leq 4, z^2 \leq x^2 + y^2 \).

4. Transform the differential equation
\[
 u''_{xx} + u''_{xy} = 0, \quad x > y > 0
\]
by introducing the new variables
\[
 s = \sqrt{y}, \quad t = \sqrt{x - y}.
\]
Then solve the equation completely.

5. Consider the function
\[
 y(x) = \int_1^{2x} \frac{\ln(t)}{1 + t^2} \, dt.
\]
Compute the derivative \( y'(1) \).

6. Compute the arclength of the curve \( \gamma : x^{2/3} + y^{2/3} = 1 \).