1. Show whether or not the following limits exist:
   
   (a) \( \lim_{(x,y) \to (0,0)} \frac{x^2y}{x^3 + 2xy^2 + y^3} \)
   
   (b) \( \lim_{(x,y) \to (0,0)} \frac{x^2y^2}{x^4 + y^2} \)

   Be sure to provide good reasons for your answers.

2. Consider the following function

   \[ f(x, y) = \begin{cases} 
   \frac{xy + x^3}{x^2 + xy} & \text{if } (x, y) \neq (0, 0), \\
   0 & \text{if } (x, y) = (0, 0). 
   \end{cases} \]

   (a) Calculate \( \frac{\partial f}{\partial x} \) if \((x, y) \neq (0, 0)\).

   (b) Calculate \( \frac{\partial f}{\partial x} \) if \((x, y) = (0, 0)\).

   (c) Is \( f(x, y) \) continuous at \((0, 0)\)? State your reasons clearly.

3. Consider the function

   \[ f(x, y) = \frac{1}{x^2 + y^2 - 1} \]

   State clearly the domains in which \( f \) is:

   (a) continuous,

   (b) a \( C^1 \) function.

   State your reasons clearly.

4. Compute the second order Taylor polynomial of

   \[ f(x, y) = \log(x^2 + 2xy + 1) \]

   near \((1, 2)\).

Note: Full working must be shown in your solutions. Marks will be deducted for incomplete working.