Tutorial Sheet:Multivariable Calculus

1. Examine if the limits as $(x, y) \to (0, 0)$ exist?

(a) $\begin{cases} \frac{x+y}{x-y} & x \neq y \\ 0 & x = y \end{cases}$ (b) $xy\left(\frac{x^2-y^2}{x^2+y^2}\right)$ (c) $\begin{cases} x\sin\frac{1}{y} + y\sin\frac{1}{x} & xy \neq 0 \\ 0 & xy = 0 \end{cases}$

(d) $\frac{\sin(xy)}{x^2+y^2}$

2. Examine the continuity of the following functions

(a) $\begin{cases} \frac{xy^2}{x^2+y^2}, & (x,y) \neq (0,0) \\ 0, & \text{otherwise} \end{cases}$ (b) $\begin{cases} x^2+y^2, & x^2+y^2 \leq 1 \\ 0, & \text{otherwise.} \end{cases}$

(c) $\begin{cases} \frac{\sin^2(x-y)}{|x|+|y|}, & (x,y) \neq (0,0) \\ 0, & \text{otherwise} \end{cases}$ (d) $\begin{cases} \frac{x^2y^2}{x^2y^2+(x-y)^2}, & (x,y) \neq (0,0) \\ 0, & \text{otherwise} \end{cases}$

3. Discuss the differentiability of the following functions at $(0, 0)$

(a) $f(x,y) = \begin{cases} x\sin\frac{1}{x} + y\sin\frac{1}{y} & xy \neq 0 \\ \text{for } y = 0 \end{cases}$ (b) $\begin{cases} \frac{xy}{\sqrt{x^2+y^2}} & x^2+y^2 \neq 0 \\ 0 & x = y = 0 \end{cases}$

(c) $\begin{cases} \frac{x^2y^2}{x^2+y^2} & x^2+y^2 \neq 0 \\ 0 & x = 0, y = 0 \end{cases}$

4. Let $f(x,y) = \frac{x}{|x|}\sqrt{x^2+y^2}$, $y \neq 0$ and $f(x,0) = 0$. Show that f has all directional derivatives at $(0,0)$ but it is not differentiable at $(0,0)$.

5. Let $f(x,y) = \left||x|-|y|\right| - |x| - |y|$. Is f continuous at $(0,0)$? Which directional derivatives [illegible] at $(0,0)$? Give reasons.

Tutorial Calculus Multivariable

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Tutorial Calculus Multivariable:

Unveiling the Magic of Words: A Review of "**Tutorial Calculus Multivariable**"

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