

5. DIFFERENTIAL CALCULUS OF FUNCTIONS OF SEVERAL VARIABLES

We have considered differential calculus of functions of one variable in Chapter 2. We now discuss differential calculus of functions expressed in terms of two or more variable. These functions are usually referred to as functions of several variables.

Definition 5.1.1

Let D be a set of n -tuples of real numbers (x_1, x_2, \dots, x_n) . A function f_n of n independent variables x_1 to x_n on D , is a rule that assigns a unique real number $w = f(x_1, x_2, \dots, x_n)$ to each element in D .

The set D is the domain of f . The set of w -values taken on by f is the function's range.

Example 5.1.1

Determine the domain and range of the following functions:

$$(a) f(x, y) = \frac{xy - 5}{2\sqrt{y - x^2}} \quad (b) f(x, y) = \sin(xy) \quad (c) f(x, y, z) = \frac{1}{x^2 + y^2 + z^2}$$

Solutions:

(a) The domain D is the set of all pairs (x, y) such that $y - x^2 > 0$, i.e.

$$D = \{(x, y) \in \mathbb{R}^2 : y > x^2\}.$$

The range is the set of all real numbers.

(b) The domain is the entire plane \mathbb{R}^2 and the range is the interval $[-1, 1]$.

(c) The domain D is the set of all pairs (x, y, z) such that $x^2 + y^2 + z^2 \neq (0, 0, 0)$, i.e.

$$D = \{(x, y, z) \in \mathbb{R}^3 : x^2 + y^2 + z^2 \neq (0, 0, 0)\}.$$

Since the denominator is positive, the range is the interval $(0, \infty)$.

5.1. LIMITS AND CONTINUITY

Definition 5.1.2

(i) The open disk, centred at (x_0, y_0) with radius r is given by

$$\{(x, y) : |(x, y) - (x_0, y_0)| < r\}.$$

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