# Functions of Several Real Variables

#### 2.1 Introduction

In Chapter 1 we studied the calculus of functions of a single real variable defined by y = f(x). In this chapter we shall extend the concepts of functions of one variable to functions of two or more variables.

If to each point (x, y) of a certain part of the x-y plane,  $x \in \mathbb{R}$ ,  $y \in \mathbb{R}$  or  $(x, y) \in \mathbb{R} \times \mathbb{R} = \mathbb{R}^2$ , there corresponds a real value z according to some rule f(x, y), then f(x, y) is called a real valued function of two variables x and y and is written as

$$z = f(x, y), x \in \mathbb{R}, y \in \mathbb{R}, \text{ or } (x, y) \in \mathbb{R}^2, z \in \mathbb{R}.$$
 (2.1)

We call x, y as the independent variables and z as the dependent variable.

In general, we define a real valued function of n variables as

$$z = f(x_1, x_2, \dots, x_n), (x_1, x_2, \dots, x_n) \in \mathbb{R}^n, z \in \mathbb{R}$$
(2.2)

where  $x_1, x_2, \ldots, x_n$  are the *n* independent variables and *z* is the dependent variable. The point  $(x_1, x_2, \ldots, x_n)$  is called an *n*-tuple and lies in an *n*-dimensional space. In this case, the function f maps  $\mathbb{R}^n$  into  $\mathbb{R}$ .

The function as defined by Eq. (2.2) is called an explicit function, whereas a function defined by  $\phi(z, x_1, x_2, \dots, x_n) = 0$  is called an *implicit* function.

We shall discuss the calculus of the functions of two variables in detail and then generalize to the case of several variables.

#### 2.2 Functions of Two Variables

Consider the function of two variables

$$z = f(x, y). (2.3)$$

The set of points (x, y) in the x-y plane for which f(x, y) is defined is called the *domain* of definition of the function and is denoted by D. This domain may be the entire x-y plane or a part of the x-y plane. The collection of the corresponding values of z is called the range of the function. The following are some examples

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**S Ben Porath** 



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