

# Functions of Several Real Variables

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## 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

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

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

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

where  $x_1, x_2, \dots, x_n$  are the  $n$  independent variables and  $z$  is the dependent variable. The point  $(x_1, x_2, \dots, x_n)$  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

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

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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**J Elliott**



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