



BUSINESS MATHEMATICS

(B.Com, BBA, BBM and BMS)



MRITUNJAY KUMAR

Business Mathematics

For B.Com, BBA, BBM and BMS

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Mritunjay Kumar
Assistant Professor
Galgotias University
Greater Noida



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E-mail: helpline@vikaspublishing.com • website: www.vikaspublishing.com

- **Ahmedabad:** 305, Grand Monarch, 100ft Shyamal Road, Near Seema Hall, Ahmedabad-380 051
• Ph. +91-79-65254204
- **Bengaluru:** First Floor, N.S. Bhawan, 4th Cross, 4th Main, Gandhi Nagar, Bengaluru-560 009
• Ph. +91-80-22281254, 22204639
- **Chennai:** E-12, Nelson Chambers, 115, Nelson Manickam Road, Aminjikarai, Chennai-600 029
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- **Hyderabad:** Aashray Mansion, Flat-G (G.F.), 3-6-36118, Street No. 20, Himayath Nagar, Hyderabad-560 029
• Ph. +91-40-23269992, Fax +91-23269993
- **Kolkata:** 6B, Rameshwar Shaw Road, Kolkata-700014
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- **Mumbai:** 67/68, 3rd Floor, Aditya Industrial Estate, Chincholi Bunder, Behind Balaji International School & Evershine Mall, Malad (West), Mumbai-400 064
• Ph. +91-22-28772545, 28768301
- **Patna:** Flat No. 101, Sri Ram Tower, Bes ide Chiraiyatand Over Bridge, Kankarbagh Main Road, Kankarbagh, Patna-800 020
• Ph. +91-612-2351147

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Preface

The objective of this book is to develop the conceptual and practical knowledge about the different tools and techniques of Business Mathematics. Language of the book has been kept lucid, so as to enable the students to understand the topics easily. Lots of illustrations have been incorporated in each chapter to clarify the concepts.

I am extremely grateful to my teachers, colleagues, and students for their support in the preparation of this book. I would like to thank the entire team of Vikas Publishing House for the effort they have put in for the publication of this book.

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UNIT-I

Chapter 1 – Matrix I

- 1.1 Introduction
- 1.2 Use of Matrix in Business
- 1.3 Types of Matrices
- 1.4 Operations of Matrices

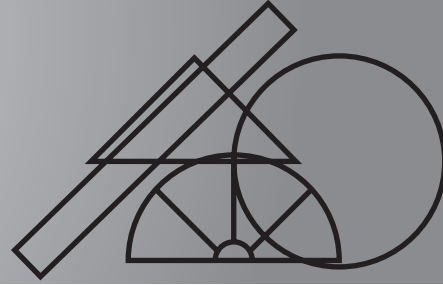
Chapter 2 – Mathematical Induction

- 2.1 Introduction
- 2.2 Working Rules for Using Principle of Mathematical Induction

CHAPTER

I

Matrix I



Chapter structure

- 1.1 Introduction
 - 1.2 Use of Matrix in Business
 - 1.3 Types of Matrices
 - 1.4 Operations of Matrices
- Exercises

Learning objective

After studying this chapter, you will be able to:

- Identify various types of matrix
- Add, Subtract and multiply matrices
- Use the matrix to solve the different types of problems

1.1 INTRODUCTION

Matrix is an important part of mathematics. It is also used in other disciplines like economics, management, engineering etc. It simplifies the mathematical calculations to a great extent. Initially matrix was used to solve simple linear equations but later on mathematicians started using to solve complex problems as well.

Definitions

Generally matrix is used to represent the large data or complicated equation into a smaller form and make the equation easy. Matrices are denoted by the capital letters like A, B, C. In matrix, data is represented in rows and columns.

Here are some examples of Matrices.

$$A = \begin{bmatrix} 1 & 4 \\ 2 & 5 \\ 3 & 6 \end{bmatrix} \begin{array}{l} \text{First Row} \\ \text{Second Row} \\ \text{Third Row} \end{array} \quad B = \begin{bmatrix} 1 & -4 & 2 \\ 6 & 9 & 4 \\ 3 & -2 & 6 \end{bmatrix} \begin{array}{l} \text{First row (R}_1\text{)} \\ \text{Second row (R}_2\text{)} \\ \text{Third row (R}_3\text{)} \end{array}$$

First Column Second Column **First Column Second Column Third Column**
C₁ C₂ C₃

1.2 USE OF MATRIX IN BUSINESS

Matrix is a useful tool in the analysis for decision making. Today it is used in different disciplines like Economics, sociology, chemistry, and physics.

Note

- (i) The horizontal arrangements of elements or entries are known as rows.
- (ii) The vertical arrangements of elements or entries are known as columns.

Two suffixes are used to identify the position of given element. The first suffix denotes the row and the second suffix denotes the column in which the element exists.

From the above example, the elements of A are $a_{11} = 1$, $a_{12} = 4$, $a_{21} = 2$, $a_{22} = 5$, $a_{31} = 3$ and $a_{32} = 6$

Order or Size of a Matrix

The order or size of a matrix is the number of rows and columns that are present in a matrix.

In the above examples order of A is 3×2 , (to be read as 3-by-2) and order of B is 3×3 , (to be read as 3-by-3).

In general a matrix A of order $m \times n$ can be written as follows:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \\ a_{j1} & a_{j2} & \dots & a_{jj} & \dots & a_{jn} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mj} & \dots & a_{mn} \end{bmatrix} \rightarrow i^{\text{th}} \text{ row}$$

j^{th}
column

It can be symbolically written as $A = [a_{ij}]m \times n$.

The element a_{ij} means, it belongs to i th row and the j th column. The above matrix A is an $m \times n$ or m -by- n matrix.

The expression $m \times n$ is the order or size or dimension of the matrix.

Illustration

Consider the following information regarding the number of men and women workers in three factories I, II and III

	Men workers	Women workers
I	30	25
II	25	31
III	27	26

Represent the above information in the form of a 3×2 matrix. What does the entry in the third row and second column represent?

Solution:

The information is represented in the form of a 3×2 matrix as follows

$$\mathbf{A} = \begin{bmatrix} 30 & 25 \\ 25 & 31 \\ 27 & 26 \end{bmatrix}$$

The entry in the third row and second column represents the number of women workers in factory III.

Illustration

Construct a 3×2 matrix whose elements are given by $a_{ij} = \frac{1}{2}|i - 3j|$.

Solution:

In general 3×2 matrix given by

$$\mathbf{A} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{bmatrix}.$$

Now $a_{ij} = \frac{1}{2}|i - 3j|$, $i = 1, 2, 3$ and $j = 1, 2$.

Therefore $a_{11} = \frac{1}{2}|1 - 3 \times 1| = 1$ $a_{12} = \frac{1}{2}|1 - 3 \times 2| = \frac{5}{2}$

$$a_{21} = \frac{1}{2}|2 - 3 \times 1| = \frac{1}{2} \quad a_{22} = \frac{1}{2}|2 - 3 \times 2| = 2$$

$$a_{31} = \frac{1}{2}|3 - 3 \times 1| = 0 \quad a_{32} = \frac{1}{2}|3 - 3 \times 2| = \frac{3}{2}$$

Hence the required matrix is given by $\mathbf{A} = \begin{bmatrix} 1 & \frac{5}{2} \\ \frac{1}{2} & 2 \\ 0 & \frac{3}{2} \end{bmatrix}$.

1.3 TYPES OF MATRICES

In this section, we will discuss different types of matrices.

Square Matrix

A matrix in which total number of rows and columns are equal, is said to be a *square matrix*. Mathematically we may define it as an $m \times n$ matrix is said to be a square matrix if $m = n$ and is known as a square matrix of order n .

For example $A = \begin{bmatrix} 3 & -1 & 0 \\ \frac{3}{2} & 3\sqrt{2} & 1 \\ 4 & 3 & -1 \end{bmatrix}$ is a square matrix of order 3.

In general, $A = [a_{ij}]_{m \times m}$ is a square matrix of order m .

Row Matrix

A matrix which has only one row is called Row Matrix.

For example $B = \begin{bmatrix} -\frac{1}{2} & \sqrt{5} & 2 & 3 \end{bmatrix}_{1 \times 4}$ is a row matrix.

In general, $A = [b_{ij}]_{m \times 1}$ is a row matrix of order $1 \times n$

Column Matrix

A matrix which has only one column is called column matrix.

For example $A = \begin{bmatrix} 0 \\ \sqrt{3} \\ -1 \\ 1/2 \end{bmatrix}$ is a column matrix of order 4×1 .

In general, $A = [a_{ij}]_{m \times 1}$ is a column matrix of order $m \times 1$.

Diagonal Matrix

A square matrix in which all elements are zero except diagonal elements, Mathematically we may define it as a matrix $B = [b_{ij}]_{m \times m}$ is said to be a diagonal matrix if $b_{ij} = 0$, when $i \neq j$ otherwise 1.

For example, $A = [4]$, $B = \begin{bmatrix} -1 & 0 \\ 0 & 2 \end{bmatrix}$, $C = \begin{bmatrix} -1.1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$, are diagonal matrices of order 1, 2, 3, respectively.

Identity Matrix or Unit Matrix

A square matrix or diagonal matrix in which diagonal elements are unity. Mathematically we may represent it as $A = [a_{ij}]_{n \times n}$ is said to be an identity matrix if

$$a_{ij} = \begin{cases} 1 & \text{if } i=j \\ 0 & \text{if } i \neq j \end{cases}$$

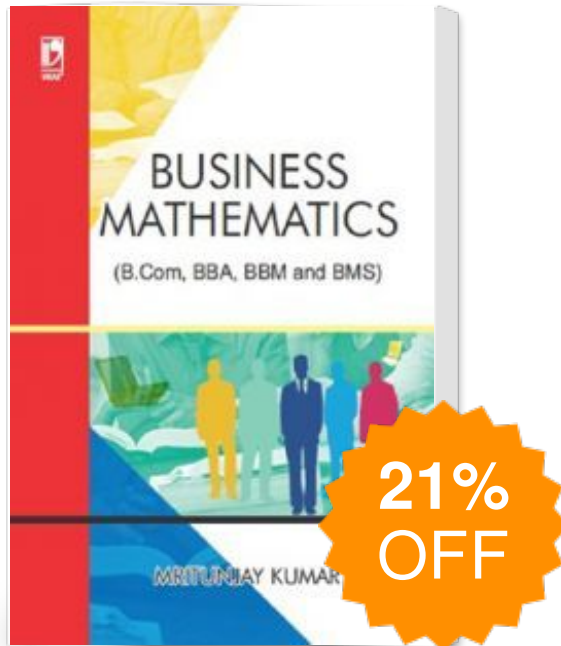
$I_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $I_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ are identity matrices.

Zero Matrix or Null Matrix or Void Matrix

A matrix in which all elements are zero is called null matrix. Mathematically we may express it as $A = [a_{ij}]_{m \times n}$ is said to be a zero matrix if i.e. $a_{ij} = 0$ for all the values of i, j .

$[0 \ 0]$, $\begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ are examples of zero matrices.

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