Chapter 1

Vector Analysis

1.1 Vectors

A vector is a physical quantity that has magnitude and direction (Fig. 1.1).

Example: Coulomb force, Electric field, Electric dipole moment, Magnetic field, Lorentz force, Magnetic vector potential, Magnetic dipole moment, Pointing vector, etc.

Vector analysis can be considered as mathematical shorthand. It has many new symbols and many new rules, and it demands lot of concentration and practice.

Scalar and Vector Fields

a) A field (scalar or vector) may be defined mathematically as some function that connects an arbitrary origin to a general point in space.

b) There is some physical effect associated with a field, such as the force on a compass needle in the earth's magnetic field, or the movement of smoke particles in the field defined by the vector velocity of air in some region of space.

c) The field concept invariably is related to a region. Some quantity is defined at every point in a region. Both scalar fields and vector fields exist.

d) The temperature throughout the bowl of soup and the density at any point in the earth are examples of scalar fields. The gravitational and magnetic fields of the earth, the voltage gradient in a cable, and the temperature gradient in a soldering-iron tip are examples of vector fields.

e) The value of a field varies in general with both position and time.

Note: Vectors will be represented in bold alphabets Example: **E**, **B**, **A**

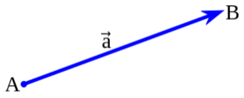

Fig. 1.1 Position Vector Representation

Vector Algebra

1. Commutative law: **A+B = B+A**

2. Associative law: **A+(B + C) = (A + B) + C**

3.Parallelogram Law: Two vectors may be added graphically either by drawing both vectors from a common origin and completing the parallelogram or by beginning the second vector from the head of the first and completing the triangle; either method is easily extended to three or more vectors (Fig. 1.2).

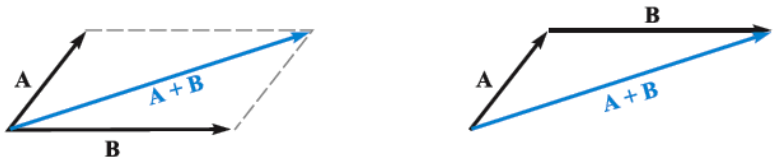

Fig. 1.2 Addition of Vectors

4. $(r+s)(\mathbf{A}+\mathbf{B}) = r(\mathbf{A}+\mathbf{B})+s(\mathbf{A}+\mathbf{B}) = r\mathbf{A}+r\mathbf{B}+s\mathbf{A}+s\mathbf{B}$

5. For **Vector Fields** we shall always add and subtract vectors that are defined at the same point.