



## Chapter One: Basic Concepts

### 1.1 Introduction

**Engineering Mechanics:** is the physical science which study the external effect of forces acting on a rigid body. It is divided into two parts: *Statics*, which concerns the equilibrium of bodies under action of forces, and *Dynamics*, which concerns the motion of bodies.

**A Rigid Body:** is a solid body in which deformation is zero or so small it can be neglected. The distance between any two given points on a rigid body remains constant before and after applying a load.

#### Scalars and Vectors Quantities:

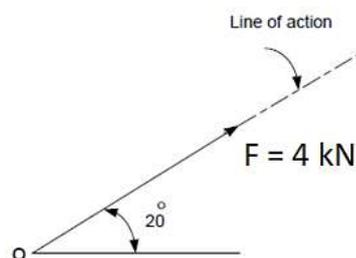
Most of the physical quantities in mechanics can be expressed mathematically by means of scalars and vectors.

**Scalar:** is physical quantity which has only magnitude. For example, mass, volume, time, and length are scalar quantities.

**Vector** is physical quantity which has both a magnitude and direction such as force, velocity, and displacement.

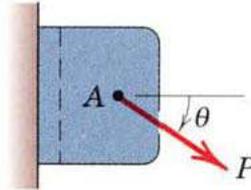
#### For Example:

The force  $F$  as shown in the Figure has a magnitude is 4 kN, and a direction is  $20^\circ$  measured from the horizontal axis.



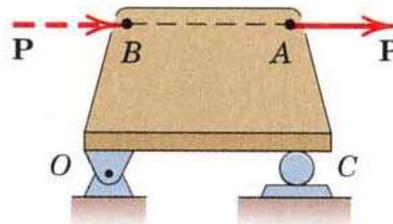
**Forces:** is the action of one body on another which changes or tends to change the motion of the body acted on. The action of a force is characterized by:

1. Magnitude.
2. Direction
3. Line of action.



Thus force is a vector quantity.

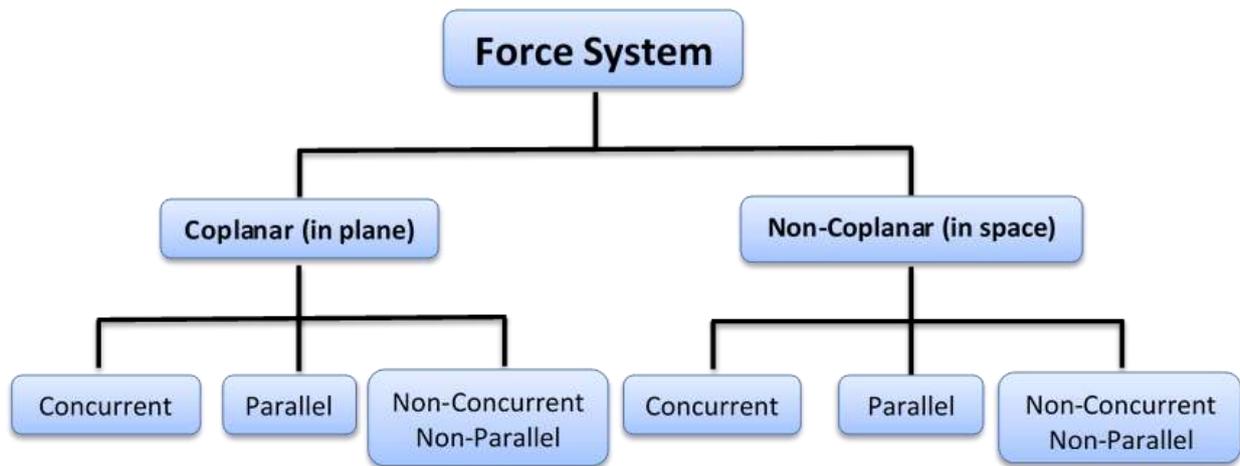
**Principle of transmissibility:** a force may be applied at any point on its given line of action and the external effects of force on the body will not change. Therefore, we need specify only the magnitude, direction, and line of action of the force, and not its point of application.



**Units of Measurement:**

Units	British Units	S.I. Units
Force	<i>lb</i>	<i>N</i>
		<i>kN = 1000 N</i>
		<i>Ton = 9.81 kN</i>
Mass	<i>slug</i>	<i>kg</i>
Area	<i>in<sup>2</sup>, ft<sup>2</sup></i>	<i>mm<sup>2</sup>, cm<sup>2</sup>, m<sup>2</sup></i>
Length	<i>in, ft</i>	<i>mm, cm, m</i>
Note	<i>ft = 0.3048 m, lb = 4.448 N</i> <i>kg = 9.81 N, N = kg.m/s<sup>2</sup></i>	

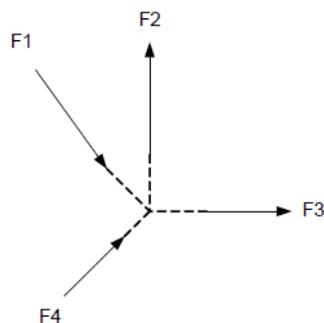
**Force System:** several forces acting in a given situation and can be classified according to the arrangement of the lines of action of the forces are called a *System of Forces* or *Force System*.



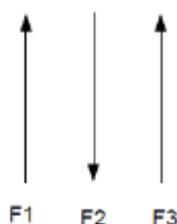
**Types of Force System: -**

**1. Coplanar Force System (In Plane): -** are classified as

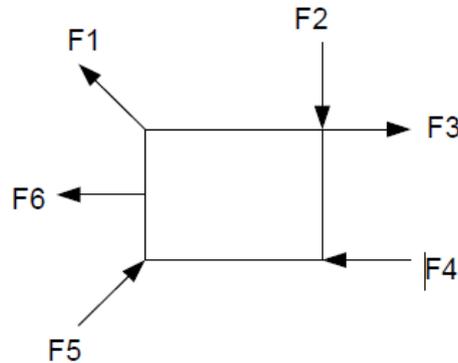
**a. A Concurrent Coplanar Force System:** - this system consists of two or more forces are said to be concurrent at one point if their lines of action intersect at the same point.



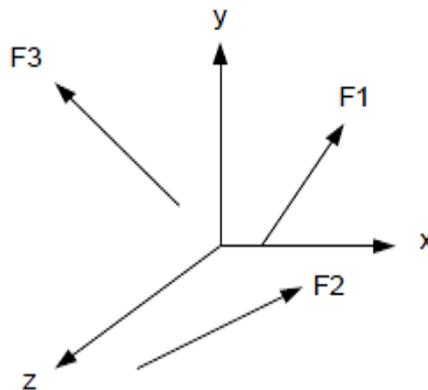
**b. Parallel Coplanar Force System:** - consists of two or more forces where the lines of action for all forces are parallel.



**c. General Coplanar Force System (Non-Concurrent & Non Parallel):** - consists of two or more forces where the lines of action various directions and do not intersect in a common point.



**2. Non-Coplanar Force System:** - systems consisting of several forces the lines of action of which lie in two planes.



**Cosine Law:**

$$A^2 = B^2 + C^2 - 2BC \cos \theta$$

$$B^2 = A^2 + C^2 - 2AC \cos \alpha$$

$$C^2 = A^2 + B^2 - 2AB \cos \beta$$

**Sine Law:**

$$\frac{A}{\sin \theta} = \frac{B}{\sin \alpha} = \frac{C}{\sin \beta}$$

