

CHAPTER 1

BASIC CONCEPTS IN MECHANICS

1.1 INTRODUCTION

The subject of mechanics is usually divided into four different subjects, which include:

1. Statics
2. Dynamics
3. Mechanics of Materials
4. Fluid Mechanics

Statics and Dynamics both deal with rigid bodies that are subjected to a system of forces. In the classical study of Statics, we are concerned with determining either internal and/or external forces acting on a structural element that is in a state of equilibrium (usually at rest). In Dynamics, the forces acting on the rigid body produce motion, and the body accelerates or decelerates. The analysis in Dynamics deals with determining position, velocity (angular or linear) and acceleration as some function of time. Newton's laws guide our study of mechanics¹. Consider Newton's second law:

$$\sum \mathbf{F} = \frac{d}{dt}(m\mathbf{v}) \quad (1.1)$$

where $\sum \mathbf{F}$ is the sum of all of the forces acting on the rigid body, m is the mass of the body; $\mathbf{v}$ is the velocity and d/dt is the derivative operator

In dividing the study of mechanics into its four subjects, scholars have considered the special situation when the velocity is constant (often zero) and developed the subject of **Statics** based on this simplification of Newton's second law. In this special situation:

$$\sum \mathbf{F} = 0 \quad (1.2)$$

We study rigid body motion in Dynamics — the velocity of the body is changing ($\mathbf{v} \neq 0$) and the general form of Eq. (1.1) applies. However, in most situations the mass of the rigid body is constant ($dm/dt = 0$) and if this is the case, Eq. (1.1) reduces to:

$$\sum \mathbf{F} = m \frac{d\mathbf{v}}{dt} = m\mathbf{a} \quad (1.3)$$

where $\mathbf{a} = d\mathbf{v}/dt$ is the acceleration of the rigid body.

¹ Sir Isaac Newton (1642-1727) formulated three laws of motion and the law of universal gravitational attraction.