ORBITS

2.1 Introduction

- Johannes Kepler (1571 ±1630) derive empirically three laws describing planetary motion.
- Kepler's laws apply quite generally to any two bodies in space which interact through gravitation.
- The more massive of the two bodies is referred to as the primary, the other, the secondary, or satellite.

2.2 Kepler's first law:

It states that the path followed by a satellite around the primary will be an ellipse. An ellipse has two focal points shown as F1 and F2

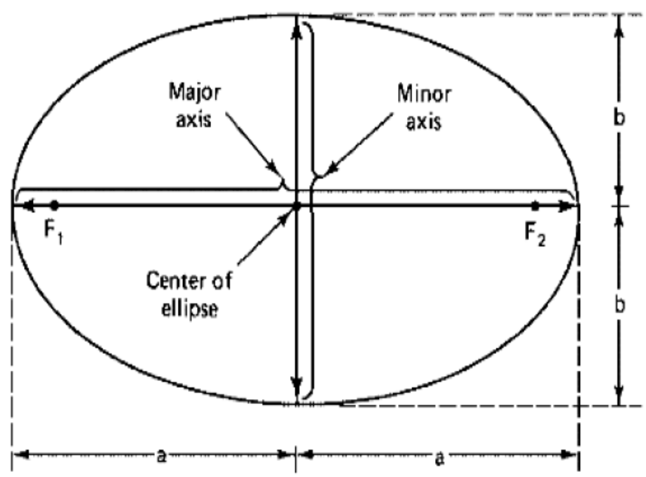

Figure 2.1 The foci F_1 and F_2, the semimajor axis a, and the semiminor axis b of an ellipse.

The center of mass of the two-body system, termed the barycenter, is always centered on one of the foci.

- In our specific case, because of the enormous difference between the masses of the earth and the satellite, the center of mass coincides with the center of the earth, which is therefore always at one of the foci.
- The semimajor axis of the ellipse is denoted by a, and the semiminor axis, by b. The eccentricity e is given by

$$e = \frac{\sqrt{a^2 - b^2}}{a}$$

For an elliptical orbit, 0 < e < 1. When e = 0, the orbit becomes circular.

2.3 Kepler`s Second Law:

Kepler's second law states that, for equal time intervals, a satellite will sweep out equal areas in its orbital plane, focused at the barycenter.

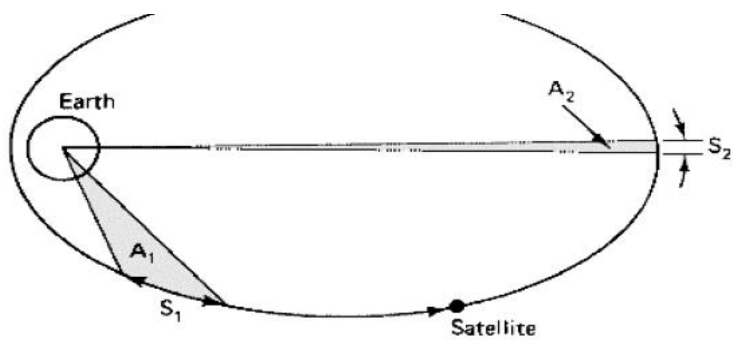

Figure 2.2 Kepler's second law. The areas A_1 and A_2 swept out in unit time are equal.

Thus the farther the satellite from earth, the longer it takes to travel a given distance

2.4 Kepler's Third Law:

It states that the square of the periodic time of orbit is proportional to the cube of the mean distance between the two bodies.

The mean distance is equal to the semimajor axis a.

For the artificial satellites orbiting the earth, Kepler's third law can be written in the form

$$a = \frac{}{n^2}$$

a = semimajor axis (meters)
n = mean motion of the satellite (radians per second)
Q = earth's geocentric gravitational constant. = 3.986005 v 1014 m3/sec2

This equation applies only to ideal situation satellite orbiting a perfectly spherical earth of uniform mass, with no pertubing forces acting, such as atmospheric drag.