Lecture 5

The Gravitational Force

* 1. **The Gravitational Force**

Newton's law of the universal gravitation states, "Any two elements of mass in the universe attract each other with a force proportional to their masses and inversely to the square of the distance between them."

F1

F2

r

Newton's law can be written in a vectorial form as:

$$\rightharpoonaccent{g}=-G\frac{m\_{1}m\_{2}}{r^{3}} \rightharpoonaccent{r}$$

where $\rightharpoonaccent{g}$ is the attraction of m1 on m2 (force of gravitation)

$\rightharpoonaccent{r}$ is the position vector from m1 to m2

G is the universal gravitational constant = 6.66 × 10-11 Nm2kg-2

If we assume m2=1 kg

$$\rightharpoonaccent{g}=-G\frac{m\_{1}}{r^{3}} \rightharpoonaccent{r}$$

If m1 = M "total mass of Earth is equal to 5.988×1024 kg"

The acceleration due to the gravitational force at the surface of Earth ( r=a=6378 km) is:

$$\rightharpoonaccent{g}\_{\*}=-G\frac{M}{a^{2}} \rightharpoonaccent{r}$$

At some altitude Z above the surface of the earth, the acceleration due to the gravitational force is:

$$\rightharpoonaccent{g}\_{\*}=-G\frac{M}{(a+z)^{2}} \rightharpoonaccent{r}$$

$\rightharpoonaccent{r}$ is the position vector from the center of Earth to the parcel in the atmosphere.

$\rightharpoonaccent{g}\_{\*}$ is directed toward the center of Earth.