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Geostationary Satellites: Their positions from the surface of the Earth

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Abstract:
Geostationary satellites are very important for humankind. They communicate with the stations situated on the Earth. And these stations exchange essential services to humans. Our aim is to find the required distance of the satellite from the surface of the Earth so as to connect with stations on the Earth.
Keywords: G*eostationary, orbit, period.*

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I. Introduction:

Satellites are the bodies (heavenly or artificial depending upon the nature made and man-made) that revolve around some other heavenly body. A man-made satellite is an artificial body that orbits around a planet. Moon is a natural satellite to our Earth and it takes 27.32 days (approximately) to revolve around the Earth. The radius of the Moon's orbit is 384400 km.

An artificial satellite broadcasts signals from geostationary orbits to man-made stations on Earth. These stations contain antenna spread over a large area more than a football ground. The satellite orbits Earth once every day (with a time period of 1day) from a fixed distance. Thus it remains at the same position above the Earth's sky. And it can be seen from a place on our planet. We need to find the height of the satellite from the Earth's surface. We know that it is 36000 km (calculated earlier).

Section1:
We will make use of the Kepler's 3rd law of planetary motion. It says-The square of the planet's period is proportional to the cube of its mean distance from the Sun. The law is equally applicable to satellite-planet pair since mass of the planet Earth is significantly more massive than the mass of the orbiting satellite.

Section2:
Mathematically we can write

$T^2 \propto R^3$ (1)

or

$T^2 = kR^3$ (2)

where

k = is a constant of proportionality

T = the time period of the satellite and

R = the distance between two bodies.

From the Earth-Moon pair of objects, we have

$k = T^2/R^3$

$= (27.32)^2 / (384400)^3$

$= 1.314\times10^{-14}$

In the case of Earth-satellite pair of objects

T = 1 day since the satellite is geostationary

$k = 1.314\times10^{-14}$ (k is unchanged for a planet)

Hence

$R = (T^2/k)^{1/3}$

$= (1^2/1.314\times10^{-14})^{1/3}$

$= 42377$ km

The radius of the Earth is 6400 km. Therefore the distance of the satellite from the surface of the Earth is equal to
$42377 - 6400 = 35977$ km ≈ 36000 km
Hence a geostationary satellite is placed in an orbit at a distance of 36000 km from the surface of the Earth.

II. Conclusion:

In this way we can calculate a satellite's orbital distance around the planet Earth or any other planet.

Reference:

[1]. Introduction to Astronomy and Cosmology by Ian Morison.

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