BECE310L – SATELLITE COMMUNICATION

DIGITAL ASSIGNMENT - 1

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(1) Register Number : 21BEC1851

So,

Perigee = 1851 km

Apogee = 11851 km

(a) Orbital Period $\Rightarrow T = 2\pi\sqrt{\frac{a^3}{\mu}}$

$$a = \frac{\text{Perigee} + \text{Apogee} + 2 \times \text{Earth's Radius}}{2}$$

$$= \frac{1851 + 11851 + 2 \times 6378.137}{2}$$

$$a = 13229.137 \text{ km}$$

$$T = 2\pi\sqrt{\frac{13229.137^3}{3.986004418 \times 10^5}}$$

$$T = 15142.872 \text{ s}$$

$$T = 4 \text{ hr } 12 \text{ min } 22 \text{ sec}$$

(b)

$$e = 1 - \frac{r_0 + \text{Perigee}}{a}$$

$$= 1 - \frac{6378.137 + 1851}{13229.135}$$

$$e = 0.37795$$

(c)

$$T = 2\pi\sqrt{\frac{a^3}{\mu}} \quad \text{(Elliptical Orbit)} \quad (1)$$

$$T_c = 2\pi\sqrt{\frac{r_c^3}{\mu}} \quad \text{(Circular orbit)} \quad (2)$$

Equating (1), (2)

$\because$ Time taken is same

$$2\pi\sqrt{\frac{a^3}{\mu}} = 2\pi\sqrt{\frac{r_c^3}{\mu}}$$

$$\sqrt{a^3} = \sqrt{r_c^3}$$

$$a^3 = r_c^3$$

$$a = r_c$$

$$\boxed{r_c = 13229.14 \text{ km}}$$

② ⓐ $\theta_{3\,dB} = \frac{75\lambda}{D} \Rightarrow D = \frac{75\lambda}{\theta_{3\,dB}}$

$Gain = \frac{33000}{(\theta_{3\,dB})^2} \qquad \lambda = \frac{c}{f}$

The transmitting antennas on satellite operate at lower freq in each band:

For 11.5 GHz : $\lambda = 0.02609$ m

$$D = \frac{75 \times 0.02609}{1.8} = 1.087 \text{ m}$$

For 20 GHz : $\lambda = 0.015$ m

$$D = \frac{75 \times 0.015}{1.8} = 0.625 \text{ m}$$

$$G = \frac{33000}{1.8^2} = 10.185 \text{ or } 40.1 \text{ dB}$$

ⓑ The receiving antennas on satellite operate at higher freq in each band.

For 14.0 GHz : $\lambda = 0.02143$ m

$$D = \frac{75 \times 0.02413}{1.8} = 0.893 \text{ m}$$

For 30.0 GHz, $\lambda = 0.01$ m

$$D = \frac{75 \times 0.01}{1.8} = 0.417 \text{ m}$$

$G = 33000 / 1.8^2 = 10.185$ or 40.1 dB

(3)

Geostationary Satellite position :

GISAT -30, Positioned at 83° E

Earth Station :

Let's consider Bangalore.

Latitude : 12.9716° N

Longitude : 77.5946° E

central Angle :

$$\cos(\gamma) = \cos(Le)\cos(Ls - le)$$

$$= \cos(12.9716)\cos(83 - 77.5946)$$

$$= 0.97015$$

$$\boxed{\gamma = 14.034^\circ}$$

$\gamma < 81.3$

So satellite is visible from Bangalore

Elevation Angle:

$$El = \tan^{-1}\left[\frac{6.6107345 - \cos\gamma}{\sin\gamma}\right] - \gamma$$

$$= \tan^{-1}\left[\frac{6.6107345 - 0.10298}{0.99468301}\right] - 14.034$$

$$\boxed{EL = 67.2758364}$$

Intermediate Angle α

$$\alpha = \tan^{-1}\left[\frac{\tan|ls - le|}{\sin(Le)}\right]$$

$$= \tan^{-1}\left[\frac{\tan|83 - 77.59461|}{\sin(12.9716)}\right]$$

$$\boxed{\alpha = 13.4968}$$

Azimuth Angle:

$$Az = 180^{\circ} - \alpha = 180^{\circ} - 13.4968$$

$$= ~~109.33~~ = 166.5032$$

4)

- Chandrayaan-3, India’s third mission to the moon, was launched successfully on July 14th, 2023 from the Satish Dhawan Space Centre at Sriharikota in Andhra Pradesh.
- It had a goal of landing on the moon’s surface in order to be more focused on the lunar south pole region. The operation intended for a gentle touchdown upon the lunar surface and conduct scientific experiments aimed at studying the terrain, composition and existence of water ice on that moon.
- The orbiter was not part of Chandrayaan-3 since the Chandrayaan-2 orbiter was still operational and was expected to support the mission. The mission included an orbiter as well as a rover (Pragyan) and lander (Vikram).

Spaceflight and Earth Orbit:

- Initially, the GSLV Mk III rocket, also known as LVM-3, carried the mission into space. This is India's most powerful rocket with a capability to support interplanetary missions.
- After separation from the launch vehicle, it entered earth’s elliptical orbit.
- It then performed a series of engine burns to boost its velocity to escape into moon’s orbit and gradually move away from earth.

Descent and Deorbit:

- Once on low lunar orbit the spacecraft executed a deorbit burn in order for it to start its descent towards Moon’s surface.
- The lander module called Vikram separated from the orbiter module and began descending toward the surface.
- Using propulsion systems combined with guidance algorithms, Vikram was able to achieve controlled landing on moon’s surface.

Landing Gently:

- On August 23 2023, Vikram softly descended near the south pole of Moon.
- This achievement made India become just fourth country that succeeded in making a soft touchdown at Moon.

Scientific studies:

- After landing on the surface of the moon Vikram released Pragyan, which is robotic rover who started exploring around lunar landspace.
- Both Vikram and Pragya performed various scientific experiments aimed at studying geology, mineralogy of moon and presence of water ice on its surface.
- With a successful mission on Chandrayaan-3, there was a great milestone in India’s space program. It did not only show the technological capacity of the country but also produced significant scientific information about the moon and its possibilities for future exploration.