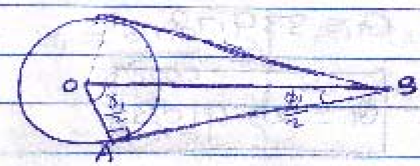
Antenna Theory and Design

Homework 19

9.3.17) A geostationary satellite is 42,000 km from the center of earth. If the -3-dB pattern points fall near edge of earth, find an approximate value for spacecraft antenna gain. Note that result is independent of frequency

Sol



From the given problem we have

$$OS = 42000 \text{ km}$$

$$OA = 6400 \text{ km}$$

→ In the problem it was mentioned as 3dB pattern is on the edge. So $O\hat{A}S = 90°$

$$\sin\left(\frac{\phi_1}{2}\right) = \frac{OA}{OS} = \frac{6400}{42000}$$

$$\Rightarrow \frac{\phi_1}{2} \approx 8.692°$$

$$\Rightarrow HP_E° = HP_H°$$

⇒ Gain of spacecraft antenna is given by

$$G = \frac{26000}{HP_E^{\circ}\, HP_H^{\circ}}$$

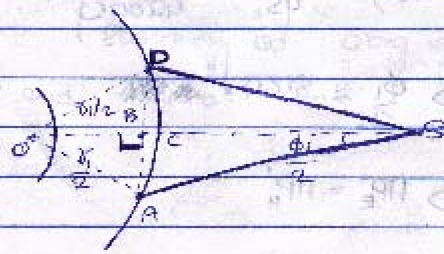
$$= \frac{26000}{8.692^{\circ}}$$

$$G = 339.72$$

$$\boxed{G = 25.91\,dB}$$

Q.6-15) A geostationary satellite transmit at 4GHz using a parabolic reflector antenna. The peak of beam is directed toward center of earth disk and 3dB pattern points fall on edge of earth. Find gain in decibels (Earth radius = 6400km, distance from center of earth orbit = 42,000 km)

Sol



From the given data

$OC = 6400 km$

$OA - R = 6400 km$

$OS = 42000 km$

$$\boxed{AB = R\sin\left(\frac{\theta_1}{2}\right)}$$

$$\Rightarrow \theta_1 = \frac{6000}{6400} \Rightarrow \left[\begin{array}{l} AD = R \times \theta_1 \\ So\ \theta_1 = \frac{AD}{R} \end{array}\right]$$

$= 53.51°$

So $AB = 6400\sin\left(\frac{53.51}{2}\right)$

$= 2891.09 km$

From the figure:

$BS = OS - OB$

$= 42000 - R\cos\left(\frac{\theta_1}{2}\right)$

$= 42000 - 6400\cos\left(\frac{53.51}{2}\right)$

$= 42000 - 5714.8$

$= 36285.1 km$

$$\tan\left(\frac{\phi_1}{2}\right) = \frac{AB}{BS}$$

$$So\ \tan\left(\frac{\phi_1}{2}\right) = \frac{2891.09}{36285.1}$$

$\Rightarrow \frac{\phi_1}{2} = 4.55$

~~$\theta_1 = 11820$~~

Gain is given by $G = \frac{26000}{HP_E^o \cdot HP_H^o}$

$G = \frac{26000}{4.55^2}$

$= 1256.61$

$G = 30.245\,dB$