» SSP is on equator at Longitude l_s and Latitude $L_s = 0$

$$r_s = 42164.17 \text{ km} \longrightarrow \text{Radius of orbit of Satellite}$$

$$\cos El = \frac{\sin r}{(1.02288235 - 0.3025385 \cos r)^{1/2}}$$

$$\frac{r_s}{r_e} = 6.6107345$$

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

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

» **Northern Hemisphere:-**

(a)» Earth station West of Satellite ⟶

$A_z = 180 - A'$

SSP ⇒ South east of earth station

(b)» Earth station east of Satellite ⟶

$A_z = 180 + A'$

SSP ⇒ South west of earth station.

» **Southern Hemisphere:-**

(a)» Earth station West of Satellite ⟶ $A_z = A'$

SSP, north east of Earth Station

(b)» Earth station east of Satellite ⟶ $A_z = 360 - A'$

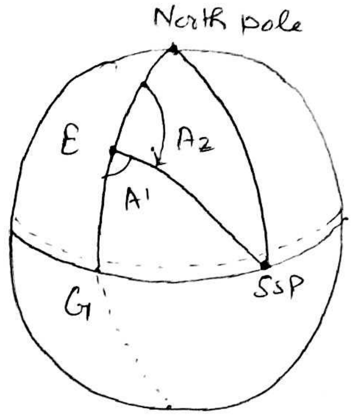
SSP, north west of Earth station

A' = Called prime angle.

SSP = Substation Point

» Northern Hemisphere-

1. Let us consider first condition earth station west of satellite

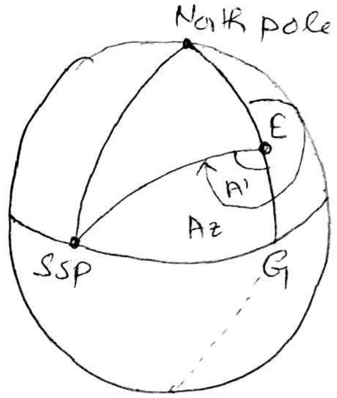


$$A' = \tan^{-1}\left[\frac{\tan|l_s - l_e|}{\sin L_e}\right]$$

$$\boxed{A_z = 180 - A'}$$

→ ssp is south east of earth station.

2. Let us consider second condition. earth station is east of satellite.



$$\boxed{A_z = 180 + A'}$$

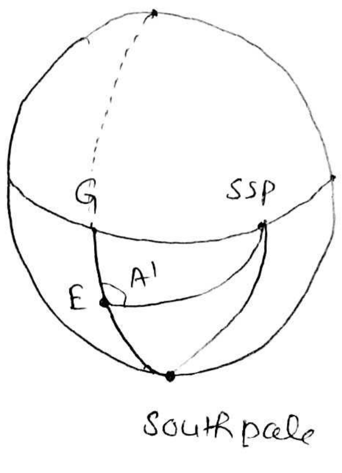
→ ssp is south west of earth station

» Southern Hemisphere:-

1. Let us consider earth station west of satellite. in southern Hemisphere-

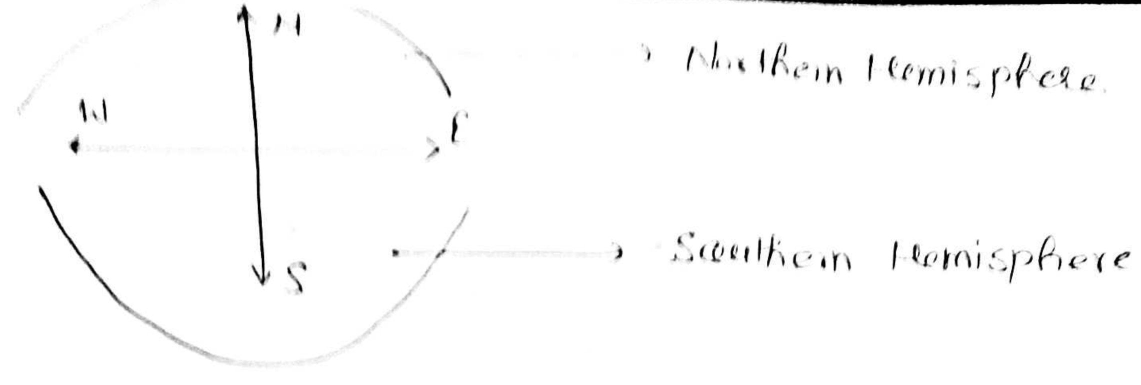
$A' = A_z$

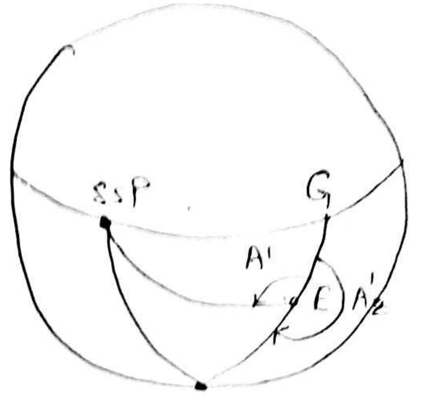
$$\boxed{A_z = A'}$$



ssp is north east of earth station.

2, Let us consider satellite is east of - earth station is east of stc satellite-





$$\boxed{A_z = 380 - A'}$$

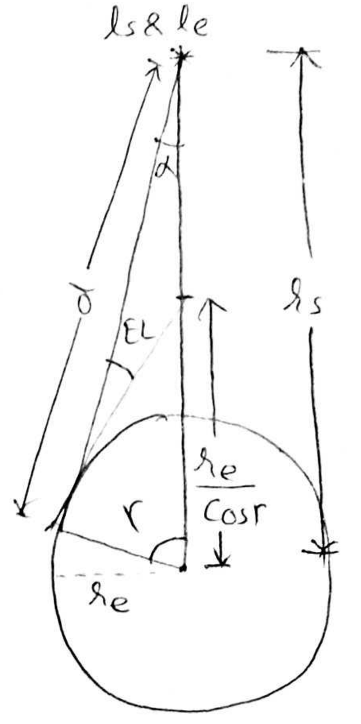
SSP is north west of earth station.

Visibility Test :-

Problem:- Earth station Longitude 80° West Latitude 40° north
Geostationary satellite northern Hemisphere 120° West.

Solution:-

r_e = Radius of earth
r_s = Radius of orbit of Satellite.



Conditions for visibility.

$$r_s \geq \frac{r_e}{\cos r}$$

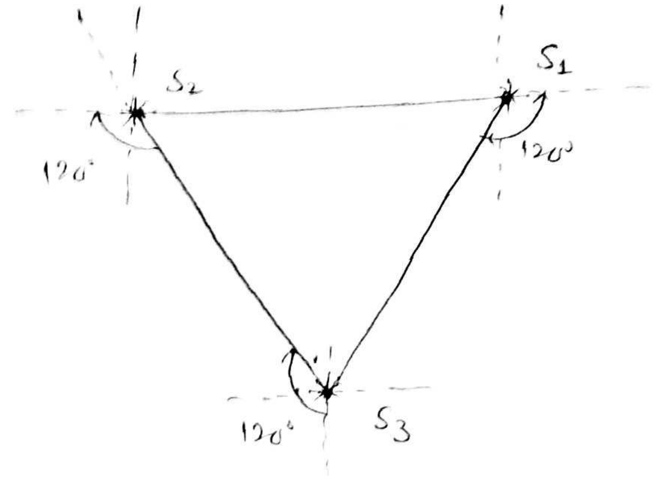
$$r \leq \cos^{-1}\left(\frac{r_e}{r_s}\right)$$

$$r \leq 81.3°$$

So $2r = 81.3° \times 2 = 162.3°$, for both side this value is less than 180°.

One Geostationary satellite can cover almost half of earth.

Hence covering full earth three satellite are arranged at 120° each as shown in the figure.



maximum coverage angle α:-

maximum coverage angle α can be calculated as-

$$\frac{r_e}{\sin\alpha} = \frac{r_s}{\sin(90+El)} = \frac{r_s}{\cos El}$$

$$\sin\alpha = \frac{r_e}{r_s}\cos El$$

$$\alpha = \sin^{-1}\left[\frac{r_e}{r_s}\cos El\right]$$

$$\therefore\ 2\alpha = 2\sin^{-1}\left\{\frac{r_e}{r_s}\cos El\right\}$$

$$2\alpha_{max} = 2\sin^{-1}\left(\frac{r_e}{r_s}\right).$$

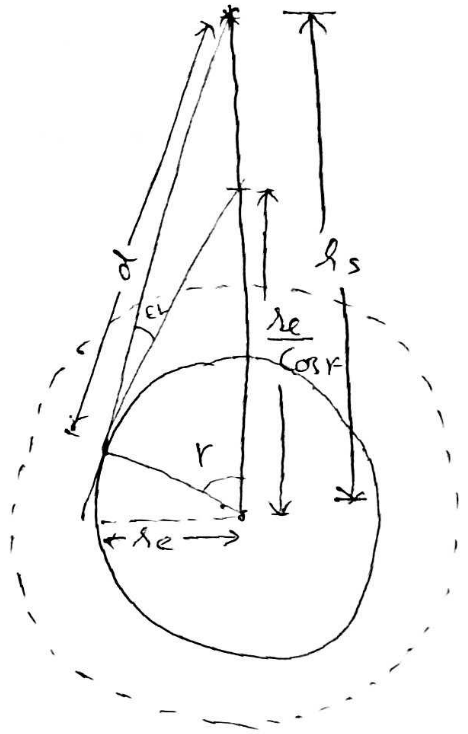
α called earth coverage angle and this angle is maximum when $El = 0°$

$\therefore \cos El = 1$

$$2\alpha_{max} = 17.40$$

minimum allowed elevation angle 5°, If El elevation angle is High then signal travel

more distance in
earth atmosphere.
Then attenuations
are increases.



If Consider Elevation angle 5°, then.

$r = 76.3°$

For 5° elevation angle.

$$d^2 = r_e^2 + r_s^2 - 2 r_e r_s \cos r$$

$d_{max} = 41127$ km.

$$\text{Round trip delay} = \frac{2d}{c}$$

$$= \frac{2 \times 41127 \times 10^3 \text{ m}}{3 \times 10^8 \text{ m/sec}} \simeq 274.$$

* **Launching of Vehicle:-** : For launching a satellite following parameters are required-

→ 1. Height of orbit
→ 2. velocity required
→ 3. velocity vector of satellite.

A satellite can-not be placed into a stable orbit unless two parameters that are uniquely coupled together - The velocity vector & orbital height- are ~~mi~~ simultaneously correct.