Examples for Parabolic Antenna

1- A parabolic dish with diameter of 3ft operates at 10GHZ , determine the approximate gain , beam width , and the distance for farfield region operation , The illumination efficiency is 55% .

Solution

D=3ft=36 inch ,, ft=12 inch ,, inch = 2.5 cm .

D=36*2.5 = 90 cm

f=10GHZ

$\lambda=\frac{C}{F}=\frac{3*10^8}{10*10^9}$ = 0.03m =3 cm .

Gain $=e_A(\frac{\pi D}{\lambda})^2=0.55(\frac{\pi*90}{3})^2=5047$ where e_A is illumination efficiency

-Gain (db) = 10 log(5047)=**37.**

-Beamwidth=$K(\frac{\lambda}{D})=70(\frac{3}{90})=2.29^\circ$,

For a "typical" parabolic antenna *k* is approximately **70.**

- **the distance for farfield** $R>\frac{2D^2}{\lambda}$ = 183ft or 2196 inch .

1- 2m radius parabolic dish is sufficient for receiving signal at frequency of 12 GHZ , what is the required distance to receive same level of signal at frequency 6GHZ.

Solution

$D_1=2r_1=2*2=4$m ,, f_1=12GHZ ,,, f_2=6GHZ/

$\lambda_1=C/f_1=0.025$m.

$\lambda_2=C/f_2=0.05$m.

same level of signal means

$Gain_1=Gain_2$

$e_A(\frac{\pi D1}{\lambda 1})^2 = e_A(\frac{\pi D2}{\lambda 2})^2$

$(\frac{D1}{\lambda 1}) = (\frac{D2}{\lambda 2})$

D_2=8m ,, r_2=4m .

3-Assuming Aperature efficiency is 70% , what is the gain of parabolic dish antenna as function of it's radius.

Solution

Aperature efficiency is 70% (K=70%)

D=2r

Gain =$e_A(\frac{\pi D}{\lambda})^2$

G=0.7 $(\frac{\pi *2r}{\lambda})^2$

G=0.7 $\frac{4\pi^2 *r^2}{\lambda^2}$

G=27.6 $(\frac{r^2}{\lambda^2})$

4- 1m diameter parabolic dish is used as receiving antenna for satellite TV reception at 6GHZ ,, determine at 3GHZ the HPBW if the same level of signal is received .

Solution

- D_1=1m ,,
- F_1= 6GHZ , F_2=3GHZ.

λ_1 =C/F_1=0.05 m .

λ_2 =C/F_2=0.1m .

the same level of signal means

$G_1 = G_2$

$e_A(\frac{\pi D1}{\lambda 1})^2 = e_A(\frac{\pi D2}{\lambda 2})^2$

$(\frac{D1}{\lambda 1}) = (\frac{D2}{\lambda 2})$

D_2=2m , r_2=1m

-HPBW = K $(\frac{\lambda}{D})$ =70$(\frac{\lambda}{D})$

-For a "typical" parabolic antenna *k* is approximately **70.**

- If we choose λ_1 & D_1

HPBW=70$(\frac{\lambda 1}{D 1})$

HPBW =3.5°

5- Calculate the directivity of an antenna with circular aperature of diameter 3m of frequency 5GHZ ..

Solution

D=3m , r=1.5m .

F=5GHZ.

λ =C/f =0.06m

circular aperature , $A_{emax} = \pi r^2$.

$A_{emax} = A_e$ as η =100% .

$A_e = \pi r^2 = \pi (1.5)^2$.

Directivity $= \frac{4\pi Ae}{\lambda^2}$

Directivity = 24674

Example on spherical reflector

-for a given maximum aperture size there exists a maximum value of total allowable phase error, and it is given by

$$\left(\frac{a}{R}\right)^4_{max} = 14.7\frac{(\Delta/\lambda)_{total}}{(R/\lambda)}$$

- where *(Δ/λ)* is the total phase error in wavelengths

Example 15.4

A spherical reflector has a 10-ft diameter. If at 11.2 GHz the maximum allowable phase error is $\lambda/16$, find the maximum permissible aperture.

Solution: At $f = 11.2$ GHz

$$\lambda = 0.08788 \text{ ft}$$

$$\left(\frac{a}{R}\right)^4_{max} = 14.7\left(\frac{1/16}{56.8957}\right) = 0.01615$$

$$a^4 \simeq 10.09$$

$$a = 1.78 \text{ ft}$$