ANTENNA AND PROPAGATION EXERCISES

EXERCISE 1 – ANTENNA GAIN AND BEAMWIDTH

Recall that gain is given by: $G = \frac{4\pi A}{\lambda^2}\eta$

The wavelength λ can be calculated from $c = f\lambda$, such that $\lambda = \frac{c}{f} = \frac{3\times10^8}{8\times10^9}$ = 0.0375m

Antenna area is $A = \frac{\pi D^2}{4}$=38.5 m^2

Efficiency η = 0.6

Substituting these into the equation for gain gives: G = 206424 = 53.1 dBi

Beamwidth is calculate from $\theta_h = \frac{70\lambda}{D}$ = 0.375 degrees.

EXERCISE 2 – VARIATION OF GAIN & BEAMWIDTH WITH FREQUENCY

As in example 4, the gain is calculated from $G = \frac{4\pi A}{\lambda^2}\eta$

The wavelength $\lambda = \frac{c}{f} = \frac{3\times10^8}{7.5\times10^9}$ = 0.04m

Antenna area is $A = \frac{\pi D^2}{4}$=38.5 m^2

Efficiency η = 0.55

The gain is thus 56.3 dBi.

Beamwidth is $\theta_h = \frac{70\lambda}{D}$ = 0.25 degrees.

Note that gain increases as frequency increases. This is because gain increases with $1/\lambda^2$, so as frequency increases, wavelength decreases and gain increases. We would thus expect that, as we increase the antenna diameter in wavelengths, the gain will increase and the beamwidth will decrease.

EXERCISE 3 – ANTENNA POINTING ACCURACY

To solve this problem simply solve the pointing loss equation for a loss of 1dB.

$$L_P \approx 12\left(\frac{\theta_P}{\theta_h}\right)^2$$

So that $\theta_P = \theta_h\sqrt{\frac{1}{12}}$

As $\theta_h = 0.375$ and $L_P = 1$

$$\theta_P = 0.375\sqrt{\frac{1}{12}} = 0.108 \text{ degrees}$$

We thus need to point the antenna to within 0.108 degrees of the satellite.