Antenna Theory and Design

Homework - 7

1) Given transmitting power $P_t = 100W$

$D = 1.9$ feet

$= 1.9 \times 0.3048$

$= 0.579 km$

Frequency $= 12.1 - 12.7$ GHz

$= 12.4$ GHz (Center frequency)

Effective area of transmitting antenna $A_{e_t} = 5m^2$

distance $R = 23500$ mile

$= 23500 \times 1.609$ Km

$= 37811.5$ Km

Effective resistance of receiving antenna $= 400\Omega$

$$P_r = \frac{P_t A_{e_t} A_{e_r}}{R^2 \lambda^2}$$

$$P_r(dBW) = P_t(dBW) + G_t(dB) + G_r(dB) - 20\log R(Km) - 20\log f(MHz) - 32.44$$

$$A_{er} = \frac{\pi D^2}{4}$$

$$= \frac{\pi (0.579)^2}{4}$$

$$= 0.263$$

$$\lambda = \frac{c}{f}$$

$$= \frac{3.8\times10^8}{12.4\,GHz}$$

$$\boxed{\lambda = 0.03m}$$

$$G_{r} = \frac{4\pi A_{er}}{\lambda^2}$$

$$= \frac{4\pi}{(0.03)^2}(0.263)$$

$$= 3672.1$$

$$\boxed{G_r(dB) = 35.6(dB)}$$

$$G_t = \frac{4\pi A_{e_t}}{\lambda^2}$$

$$= \frac{4\pi}{(0.03)^2}(5)$$

$$= 69813.17$$

$$\boxed{G_t(dB) = 48.4\ (dB)}$$

given $P_t = 100W$

$$= 20(dB)$$

$$P_r(dBW) = 20 + 48.4 + 35.6 - 20\log(37811.5) - 20\log(12400) - 32.44$$

$P_R(dBW) = 20 + 48.4 + 35.6 - 91.55 - 81.8 - 32.44$

$= -101.74\ dBW$

$P_R = 2.06 \times 10^{-12}$ watts

$V_A = \sqrt{8 R_0 P_R}$

$= \sqrt{8(400)(2.06 \times 10^{-12})}$

$V_A = 8.119 \times 10^{-5} V$

12) given $f = 10\,GHz$

diameter $d = 3$ feet

$= 3 \times 0.3048$

$= 0.9144$ mt

Power density $S_{inc} = \frac{P_R}{A_{em}}$

$\lambda = \frac{c}{f}$

$= \frac{3.8 \times 10^{8}}{10 \times 10^{9}}$

$\lambda = 0.038\ m$

Gain $G_r = G_t = 0.65(4\pi A_{physical}/\lambda^2)$

$R = 20$ miles

$= 32.18$ Km

$= 0.65\pi^2\left(\frac{d^2}{\lambda^2}\right)$

$= 0.65\pi^2\left(\frac{0.914^2}{0.038^2}\right)$

$= 3711.4$

$G_r = G_t = 35.6$ dB

$P_r(dBW) = P_t(dBW) + G_r + G_t - 20\log R(Km) - 20\log f(MHz) - 32.44$

$P_t = 20W$

$= 13.01$ dB

$P_r(dBW) = 13.01 + 35.6 + 35.6 - 20\log(32.18) - 20\log(10000) - 32.44$

$= 13.01 + 35.6 + 35.6 - 30.15 - 80 - 32.44$

$= -58.38$ dB

$P_r = 3.8\times10^{-6}$ watts

Power density $S_{inc} = \frac{P_r}{A_{er}}$

$$A_{er} = \frac{\lambda^2}{4\pi} G_{r}$$

$$= \frac{(0.038)^2}{4\pi} (3711.4)$$

$$= \underline{\underline{0.426}}$$

Power density $S_{inc} = \frac{P_r}{A_{er}}$

$$= \frac{3.8 \times 10^{-6}}{0.426}$$

$$\boxed{S_{inc} = 8.92 \times 10^{-6} \frac{\mu w}{m^2}}$$

Attenuation $= P_t(dB) - P_r(dB)$

$$= 13.01 - (-58.38)$$

$$\boxed{\text{Attenuation} = 71.39 dB}$$