

Problem 9.20 A 3-GHz line-of-sight microwave communication link consists of two lossless parabolic dish antennas, each 1 m in diameter. If the receive antenna requires 10 nW of receive power for good reception and the distance between the antennas is 40 km, how much power should be transmitted?

Solution: At $f = 3$ GHz, $\lambda = c/f = (3 \times 10^8 \text{ m/s})/(3 \times 10^9 \text{ Hz}) = 0.10 \text{ m}$. Solving the Friis transmission formula (Eq. (9.75)) for the transmitted power:

$$\begin{aligned} P_t &= P_{\text{rec}} \frac{\lambda^2 R^2}{\xi_t \xi_r A_t A_r} \\ &= 10^{-8} \frac{(0.100 \text{ m})^2 (40 \times 10^3 \text{ m})^2}{1 \times 1 \times (\frac{\pi}{4} (1 \text{ m})^2) (\frac{\pi}{4} (1 \text{ m})^2)} = 25.9 \times 10^{-2} \text{ W} = 259 \text{ mW}. \end{aligned}$$
