2.98 Transmitting and receiving antennas operating at 1 GHz with gains (over isotropic) of 20 and 15 dB, respectively, are separated by a distance of 1 km. Find the maximum power delivered to the load when the input power is 150 W. Assume that the

(a) antennas are polarization-matched

(b) transmitting antenna is circularly polarized (either right- or left-hand) and the receiving antenna is linearly polarized.

Use (2-118) $$\frac{P_r}{P_t} = e_{cdt} e_{cdr} (1-|\Gamma_t|^2)(1-|\Gamma_r|^2)\left(\frac{\lambda}{4\pi R}\right)^2 D_t D_r |\hat{\rho}_t \cdot \hat{\rho}_r|^2$$

$R = 1\,\text{Km} = \underline{1000\,\text{m}}$

max. power $\Rightarrow \Gamma_t = \Gamma_r = 0$

$G_t = e_{cdt} D_t = 20\,\text{dB}_i = \underline{10^{20/10}}$

$G_r = e_{cdr} D_r = 15\,\text{dB}_i = \underline{10^{15/10}}$

$P_t = \underline{150\,\text{W}}$

$$\lambda = c/f = \frac{2.998 \times 10^8}{1 \times 10^9} = \underline{0.2998\,\text{m}}$$

a) $PLF = |\hat{\rho}_t \cdot \hat{\rho}_r|^2 = 1$

$$P_r = (150\,\text{W})(1)(1)\left(\frac{0.2998}{4\pi\, 1000}\right)^2 10^2\, 10^{1.5}\, (1)$$

$= 0.00026998\,\text{W}$

$$\underline{\underline{P_r = 270\,\mu\text{W}}}$$

b) $PLF = |\hat{\rho}_t \cdot \hat{\rho}_r|^2 = 0.5$ (e.g., $\left|\left(\frac{\hat{a}_x \pm j\hat{a}_y}{\sqrt{2}}\right) \cdot \hat{a}_x\right|^2 = 1/2$)

$$\Rightarrow \underline{\underline{P_r = 135\,\mu\text{W}}}$$