Solution

Given:

Transmitter power, $P_t = 50$ W

Carrier frequency, $f_c = 900$ MHz

Transmitter antenna gain, $G_t = 1$

Receiver antenna gain, $G_r = 2$

Receiver antenna resistance = 50 Ω

(a) Using Equation (4.5), the power received at distance $d = 10$ km is

$$P_r(d) = 10\log\left(\frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2}\right) = 10\log\left(\frac{50 \times 1 \times 2 \times (1/3)^2}{(4\pi)^2 10000^2}\right)$$

$$= -91.5 \text{ dBW} = -61.5 \text{ dBm}$$

(b) Using Equation (4.15), the magnitude of the received E-field is

$$|E| = \sqrt{\frac{P_r(d)120\pi}{A_e}} = \sqrt{\frac{P_r(d)120\pi}{G_r \lambda^2/4\pi}} = \sqrt{\frac{7 \times 10^{-10} \times 120\pi}{2 \times 0.33^2/(4\pi)}} = 0.0039 \text{ V/m}$$

(c) Using Equation (4.16), the applied rms voltage at the receiver input is

$$V_{ant} = \sqrt{P_r(d) \times R_{ant}} = \sqrt{7 \times 10^{-10} \times 50} = 0.187 \text{ mV}$$

4.4 The Three Basic Propagation Mechanisms

Reflection, diffraction, and scattering are the three basic propagation mechanisms which impact propagation in a mobile communication system. These mechanisms are briefly explained in this section, and propagation models which describe these mechanisms are discussed subsequently in this chapter. Received power (or its reciprocal, path loss) is generally the most important parameter predicted by large-scale propagation models based on the physics of reflection, scattering, and diffraction. Small-scale fading and multipath propagation (discussed in Chapter 5) may also be described by the physics of these three basic propagation mechanisms.

Reflection occurs when a propagating electromagnetic wave impinges upon an object which has very large dimensions when compared to the wavelength of the propagating wave. Reflections occur from the surface of the earth and from buildings and walls.

Diffraction occurs when the radio path between the transmitter and receiver is obstructed by a surface that has sharp irregularities (edges). The secondary waves resulting from the obstructing surface are present throughout the space and even behind the obstacle, giving rise to a bending of waves around the obstacle, even when a line-of-sight path does not exist between transmitter and receiver. At high frequencies, diffraction, like reflection, depends on the geometry of the object, as well as the amplitude, phase, and polarization of the incident wave at the point of diffraction.