Exercises week 2

1. Under the free-space path loss model, find the transmit power required to obtain a received power of 1 dBm for a wireless system with isotropic antennas ($G_t = G_r = 1$) and a carrier frequency $f_c = 5$ GHz, assuming a distance $d = 10\,\mathrm{m}$. Repeat for $d = 100\,\mathrm{m}$.
2. For the two-ray model with transmitter–receiver separation $d = 100\,\mathrm{m}$, $h_t = 10\,\mathrm{m}$, and $h_r = 2\,\mathrm{m}$, find the delay spread between the two signals.

2-5. Find the critical distance d_c under the two-ray model for a large macrocell in a suburban area with the base station mounted on a tower or building ($h_t = 20$ m), the receivers at height $h_r = 3$ m, and $f_c = 2$ GHz. Is this a good size for cell radius in a suburban macrocell? Why or why not?

10. Consider a receiver with noise power –160 dBm within the signal bandwidth of interest. Assume a single-slope path loss model with $d_0 = 1$ m, K obtained from the free-space path loss formula with isotropic antennas and $f_c = 1$ GHz, and $\gamma = 4$. For a transmit power of $P_t = 10\,\mathrm{mW}$, find the maximum distance between the transmitter and receiver such that the received signal-to-noise power ratio is 20 dB.

15. Table 2.7 lists a set of empirical path loss measurements. Assume a carrier frequency $f_c = 2$ GHz.

    (a) Find the parameters of a single-slope path loss model plus log-normal shadowing that best fit this data assuming K is calculated from free-space path loss at the reference distance $d_r = 1$ m.

    (b) Find the path loss at 2 km based on this model.

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Table 2.7: path loss measurements for Problem 2-14

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Distance from transmitter	P_r/P_t
5 m	–60 dB
25 m	–80 dB
65 m	–105 dB
110 m	–115 dB
400 m	–135 dB
1000 m	–150 dB

(c) Find the outage probability at a distance d assuming the received power at d due to path loss alone is 10 dB above the required power for non-outage.