

## Homework 1

CS378: Introduction to Wireless Networks (Spring 2009)

Assigned: Feb. 2, 2009

Due: Feb. 9, 2009

Please show the intermediate steps, not just the final answers.

1. Convert 10 W (i) into dBm, and (ii) into dBW. (10 points each)

$$10\text{W} = 10^4 \text{ mW} = 10 \log_{10} 10^4 = 40 \text{ dBm} \text{ (5 points)}$$

$$10\text{W} = 10 \log_{10} (10) = 10 \text{ dBW} \text{ (5 points)}$$

2. Suppose a transmitter produces 10 W power, what's the received power (in dBm) at distance 100 meters away from the transmitter under free-space propagation model? What's the received power under two-ray ground reflection model? (Both transmitter and receiver antenna gain is 1, and their heights are both 1m. Carrier frequency is 2.5 GHz.) (30 points)

$$\lambda = c/f = 3 \cdot 10^8 / (2.5 \cdot 10^9) = 0.12 \text{ m} \text{ (6 points)}$$

$$P_r = P_t \cdot G_t \cdot G_r \cdot \lambda^2 / ((4\pi)^2 \cdot d^2 \cdot L) = 10 \cdot 0.12^2 / ((4\pi)^2 \cdot 10^4) \text{ W} = 9.12 \cdot 10^{-8} \text{ (10 points)}$$

$$W = 10 \log_{10} 9.12 \cdot 10^{-5} \text{ dBm} = -40.4 \text{ dBm} \text{ (2 points)}$$

$$P_r = P_t \cdot G_t \cdot G_r \cdot h_t \cdot h_r / (d^4 \cdot L) = 10 / 10^8 \text{ W} = 10^{-5} \text{ mW} = -50 \text{ dBm} \text{ (12 points)}$$

3. What's the minimum signal-to-noise ratio in order to reliably support 19.2 kbps using a channel with a bandwidth of 30 kHz? (26 points)

$$\text{DataRate} = W \log_2 (1 + S/N)$$

$$19.2 = 30 \log_2 (1 + S/N)$$

$$S/N = 0.5583$$

4. What are the means to mitigate narrowband interference? What is the complexity of different solutions? (24 points)

Direct sequences spread spectrum and frequency hopping spread spectrum are ways to mitigate narrowband interference. (12 points)

Both direct sequences and frequency hopping requires time synchronization between the sender and receiver. (12 points)