

COMP4336/9336 Mobile data networking
W2 Quiz: PHY Fundamentals II

Q1. What is the received signal power (approx.) observed by a user equipment (UE) at a height of 1m from the ground and at a distance of 400 m from a 15 m high base station? The transmitter and receiver antenna gains are 10 dBi and 5 dBi, respectively. Base station transmission frequency is 1.8GHz and transmission power is 30 dBm.

- a) 30 dBm
- b) -35 dBm**
- c) 30 W
- d) 62 mW
- e) 30 dBW

A1.

$D_{\text{break}} = 4(14 \times 4 \times 2 \times 10^9 / 3 \times 10^8) = 360\text{m}$; thus at 400m, the UE is at far field and hence we can use the 2-ray model.

Path loss (dB) = $20\log_{10}[(400 \times 400) / (15 \times 1)] = \sim 80 \text{ dB}$

Therefore, $P_R = 30 \text{ dBm} + 10 + 5 - 80 = -35 \text{ dBm}$ (approx.)

Q2. With a subcarrier spacing of 100 kHz, how many subcarriers will be used in an OFDM system with 20 MHz channel bandwidth?

- a) 2
- b) 20
- c) 200**
- d) 2000
- e) None of these

A2.

Number of Subcarriers = $(20 \times 10^6) / (100 \times 10^3) = 200$

Q3. Let us consider an OFDM system that uses the same carrier spacing irrespective of the channel bandwidth used. It employs 1024 subcarriers for 20 MHz channel. How many subcarriers will be used, approximately, if the channel was 2 MHz wide?

- a) 1000
- b) 110
- c) 128
- d) 102**
- e) 256

A3.

Inter carrier spacing = $20\text{MHz}/1024 = 19.53\text{ kHz}$

Now, for a 2 MHz channel: $2 \times 10^3 / 19.53 = \sim 102$ subcarriers.

Q4. You have bought a 2.4 GHz WiFi router with two dipole antennas claiming effective antenna gain of 6 dBi. Your laptop has a single dipole with 0 dBi gain and it claims a receiver sensitivity of -60 dBm. What is the maximum distance from the router your laptop can receive data if the router always uses transmit power of 20 dBm?

- a) 10m
- b) 20m
- c) 115m
- d) 250m
- e) **200m**

A4.

We can tolerate a maximum pathloss of 86 dB ($20+6+60 = 86$). 2.4 GHz will lose 86 dB at 200 m. Beyond 200 m from the router, the laptop will receive signal strength below its sensitivity level, -60 dBm, and hence will not be able to decode information.

Q5. You have bought a 2.4 GHz WiFi router with antenna gain of 2 dBi and default transmission power of 100 mW. Your laptop has a 0 dB antenna gain and claims a receiver sensitivity of -60 dBm. Can you connect your laptop to the router from a distance of 150 m?

- a) YES
- b) **NO**

A5.

There is 83.56 dB path loss at 150 m. Therefore, the laptop will receive a signal strength of $20+2-83.56 = -61.56\text{ dBm}$, which is below its receiver sensitivity. Therefore, the laptop **cannot** connect to the router.

Q6. Which of the following statements is TRUE?

- a) An omni-directional antenna radiates power in all directions equally.
- b) **An isotropic antenna radiates power in all directions equally**
- c) A directional antenna usually has a gain of 0 dBi
- d) Antenna gain refers to the ratio of the power at a particular point to the power with omnidirectional antenna
- e) A device cannot use the same antenna for both transmission and reception

A6.

The answer should be obvious.

Q7. A lamp post would cause scattering for a 300 GHz transmission.

- a) True
- b) False**

A7.

A 300 GHz signal has a wavelength of only 1mm. Lamp posts are usually much wider objects having diameters on the order of centimeters, hence are unlikely to serve as effective scatters for such high-frequency signals.

Q8. Which of the following statements is TRUE?

- a) OFDMA uses TDMA to share subcarriers between different users
- b) OFDM could use TDMA to share subcarriers between different users**
- c) OFDM is a multiple access technology
- d) OFDMA is a multiplexing technology
- e) None of these

A8.

With multipaths, reflections from different paths keep coming to the receiver for some time, effectively widening the symbol interval.

Q9. Which of the following is a valid symbol length (bit interval) if the time difference between the first copy (LoS) and the last copy (NLoS) of the signal at the receiver is 800ns (ns=nano second)?

- a) 400ns
- b) 700ns
- c) 500ns
- d) 799ns
- e) None of these**

A9. If symbols are shorter than delay spread, then signals with significant power from previous symbol will interfere with signals from the next symbol.

Q10. Which of the following statements is FALSE?

- a) Up to 30 MIMO channels could be created between a 10-antenna base station and a 3-antenna mobile device
- b) MIMO is only useful in the presence of multipath and scattering**
- c) MIMO can work even with a single-antenna mobile device
- d) Beamforming can be achieved without having to move antennas physically
- e) a 6x3 MIMO refers to 6 Tx antennas and 3 Rx antennas

A10. Even for LoS-only scenarios, the separation of multiple antennas in MIMO leads to uncorrelated LoS paths, thus providing spatial diversity benefits.

End of Quiz-2
