Assignment 3

ECE1150 - Introduction to Computer Networks
University of Pittsburgh
(100 points)

1. (10 points) Briefly explain the principle behind the operation of optical fiber.

2. (10 points) Compare between the different wired physical transmission medium (twisted pair cable, coaxial cable, multimode optical fiber, single mode optical fiber) in terms of noise susceptibility and capacity. Comment on the relation between noise susceptibility and capacity (Hint: use Shannon's Theorem).

3. (10 points) What do you mean by attenuation of a signal? What is the impact of the distance of the link on the attenuation? How is it different in wired and wireless links?

4. (10 points) Describe the different sections of the electromagnetic spectrum along with the associated frequencies, wavelengths and example applications.

5. (20 points) Consider the signal received by a device from an access point.
   (a) (6 points) If the access point operates at a power level of 85 watts, what is the signal strength in dBm?
   (b) (6 points) The signal attenuates 12 dB every 1 km. What is the received power after 10 km?
   (c) (2 points) If the receiver sensitivity is -75 dBm, could the receiver detect the signal?
   (d) (6 points) If the noise power at the laptop is -65 dBm, what is the SNR in dB?

6. (5 points) Consider a phone network that uses a channel with bandwidth of 8 kHz and operates at an SNR of 82 dB. What is the capacity of the channel?

7. (5 points) If the channel capacity is 36Mbps, and bandwidth is 9MHz, what is SNR of the channel?

8. (20 points) (a) (10 points) The transmit power of a TV satellite is 85 W and the diameter of the reflector of the transmit antenna is 180 cm. The diameter of the receive antenna is on 270 cm. Distance from the satellite to Pittsburgh is 50 000 km, frequency is 12.2 GHz. How many dBm is the signal received by the receive antenna? $\eta = 0.6$.

$$\text{Antenna Gain} = 10log[\eta(\frac{\pi D}{\lambda})^2]dB$$

D = diameter of antenna, $\lambda = \frac{c_0}{f}$, c_0 = speed of light, and f = frequency.

$$\text{Free space loss} = 10log[(\frac{4\pi r}{\lambda})^2]dB$$

r = distance between transmitter and receiver.

(b) (10 points) A satellite link has a frequency of 13 GHz. The satellite antenna reflector size is 1.5 m, the ground station has a 2.5 m antenna. The aperture efficiency of each antenna is 70% (η = 0.7). The power received by the ground station (i.e. the input signal power to the receiver) is -70 dBm. What must be the transmit power of the satellite transmitter?

9. (10 points) A floor with a rectangular layout has area 30x40 m^2. IoT devices are spread out in the area, each has a sensitivity of -95dBm. We need to connect all devices in this floor to the wireless LAN using access points. Each access point can transmit at a power of 1mW and operate at 2.7GHz. The path loss exponent in the environment is 5. Can we use a single access point to connect the devices? Justify your answer.