CHAPTER 7

PRACTICE SET

Questions

Q7-1. *Twisting* ensures that both wires are equally, but ***inversely***, affected by external influences such as noise.

Q7-2. The two major categories are *guided* and *unguided* media.

Q7-3. The *inner core* of an optical fiber is surrounded by *cladding*. The core is denser than the cladding, so a light beam traveling through the core is reflected at the boundary between the core and the cladding if the incident angle is more than the critical angle.

Q7-4. *Omnidirectional* waves are propagated in all directions; unidirectional waves are propagated in one direction.

Q7-5. In *sky propagation* radio waves radiate upward into the ionosphere and are then reflected back to earth. In *line-of-sight propagation* signals are transmitted in a straight line from antenna to antenna.

Q7-6. We can mention three advantages of optical fiber cable over twisted-pair and coaxial cables: *noise resistance*, *less signal attenuation*, and *higher bandwidth*.

Q7-7. *Guided media* have physical boundaries, while unguided media are unbounded.

Q7-8. *Refraction* and *reflection* are two phenomena that occur when a beam of light travels into a less dense medium. When the angle of incidence is less than the critical angle, *refraction* occurs. The beam crosses the interface into the less dense medium. When the angle of incidence is greater than the critical angle, *reflection* occurs. The beam changes direction at the interface and goes back into the more dense medium.

Q7-9. The *transmission media* is located beneath the physical layer and controlled by the physical layer.

Q7-10. The three major categories of guided media are *twisted-pair*, *coaxial*, and *fiber-optic* cables.

Problems

P7-1. See the following table (the values are approximate).

Distance	*dB at 1 KHz*	*dB at 10 KHz*	*dB at 100 KHz*
1 Km	−1	−1.5	−3
10 Km	−10	−15	−30
15 Km	−15	−22.5	−45
20 Km	−20	−30	−60

P7-2. As the table in P7-1 and Figure 7.6 shows, the attenuation/distance is proportional to the bandwidth. This means

$$\text{attenuation/distance} = k \times \text{bandwidth}$$

$$\text{attenuation} = k \times \text{bandwidth} \times \text{distance}$$

This means that if we set a fixed value for attenuation, the bandwidth decreases with an increase in distance.

P7-3. We can use the formula $f = c / \lambda$ to find the corresponding frequency for each wave length as shown below (c is the speed of propagation):

a. $B = [(2 \times 10^8)/1000 \times 10^{-9}] - [(2 \times 10^8)/ 1200 \times 10^{-9}] = 33 \text{ THz}$

b. $B = [(2 \times 10^8)/1000 \times 10^{-9}] - [(2 \times 10^8)/ 1400 \times 10^{-9}] = 57 \text{ THz}$

P7-4. See the following table (the values are approximate). Since the bandwidth in Figure 7.9 is in MHz, it is difficult to get accurate values for dBs.

Distance	*dB at 1 KHz*	*dB at 10 KHz*	*dB at 100 KHz*
1 Km	−0	−0	−1
10 Km	−0	−0	−10
15 Km	−0	−0	−15
20 Km	−0	−0	−20

P7-5. As the table in P7-4 and Figure 7.9 shows, the attenuation/distance is proportional to the bandwidth. This means

$$\text{attenuation/distance} = k \times \text{bandwidth}$$

$$\text{attenuation} = k \times \text{bandwidth} \times \text{distance}$$

This means that if we set a fixed value for attenuation, the bandwidth decreases with an increase in distance.

P7-6. The delay = distance / (propagation speed). Therefore, we have:

a. Delay = $5 / (2 \times 10^8) = 25$ ns

b. Delay = $500 / (2 \times 10^8) = 2.5$ μs

c. Delay = $1000/(2 \times 10^8) = 5$ μs

P7-7. See the following table (The values are approximate).

Distance	*dB at 800 nm*	*dB at 1000 nm*	*dB at 1200 nm*
1 Km	−3	−1.1	−0.5
10 Km	−30	−11	−5
15 Km	−45	−16.5	−7.5
20 Km	−60	−22	−10

P7-8. We can use the table in P7-4 to find the power for different frequencies:

1 KHz	dB = −3	$P_2 = P_1 \times 10^{-3/10}$	= 100.23 mw
10 KHz	dB = −7	$P_2 = P_1 \times 10^{-7/10}$	= 39.90 mw
100 KHz	dB = −20	$P_2 = P_1 \times 10^{-20/10}$	= 2.00 mw

The table shows that power is decreased 150 times for 100 KHz, which is unacceptable for most applications.

P7-9. We can use the table in P7-1 to find the power for different frequencies:

1 KHz	dB = −3	$P_2 = P_1 \times 10^{-3/10}$	= 100.23 mw
10 KHz	dB = −5	$P_2 = P_1 \times 10^{-5/10}$	= 63.25 mw
100 KHz	dB = −7	$P_2 = P_1 \times 10^{-7/10}$	= 39.90 mw

The table shows that the power is reduced 5 times, which may not be acceptable for some applications.

P7-10.

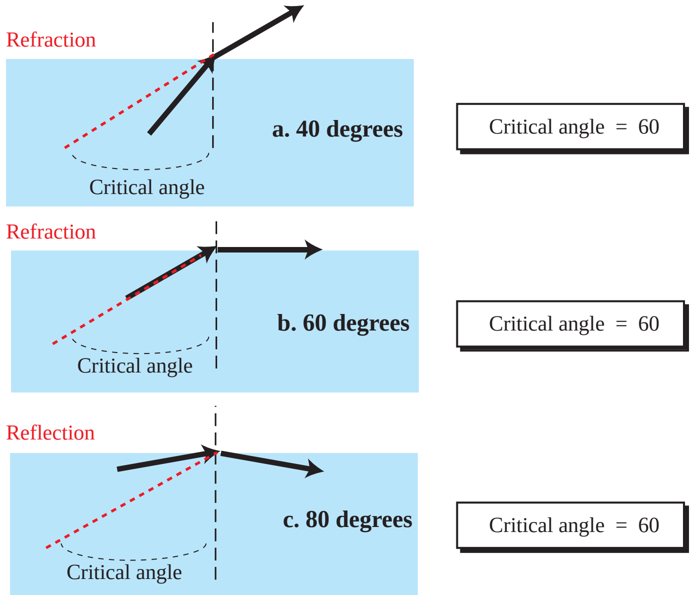
a. The *wave length* is the inverse of the frequency if the propagation speed is fixed (based on the formula $\lambda = c / f$). This means all three figures represent the same thing.

b. We can change the wave length to frequency. For example, the value 1000 nm can be written as 200 THz.

c. The vertical-axis units may not change because they represent dB/km.

d. The curve must be flipped horizontally.

P7-11. See the following figure.



a. The incident angle (40 degrees) is smaller than the critical angle (60 degrees). We have *refraction*.The light ray enters into the less dense medium.

b. The incident angle (60 degrees) is the same as the critical angle (60 degrees). We have *refraction*. The light ray travels along the interface.

c. The incident angle (80 degrees) is greater than the critical angle (60 degrees). We have *reflection*. The light ray returns back to the more dense medium.