CHAPTER 7 (corrisponde al cap. 6 italiano)

Transmission Media

Solutions to Review Questions and Exercises

Review Questions

1. The ***transmission media*** is located ***beneath the physical layer*** and controlled by the physical layer.
2. The two major categories are ***guided*** and ***unguided*** media.
3. ***Guided media*** have physical boundaries, while ***unguided media*** are unbounded.
4. The three major categories of guided media are ***twisted-pair***, ***coaxial***, and ***fiber-optic*** cables.
5. ***Twisting*** ensures that both wires are equally, but ***inversely***, affected by external influences such as noise.
6. ***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.
7. 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.
8. We can mention three advantages of optical fiber cable over twisted-pair and coaxial cables: ***noise resistance***, ***less signal attenuation***, and ***higher bandwidth.***
9. 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.
10. ***Omnidirectional*** waves are propagated in all directions; ***unidirectional*** waves are propagated in one direction.

Exercises

11. See Table 7.1 (the values are approximate).

Table 7.1 *Solution to Exercise 11*

Distance	*dB at 1 KHz*	*dB at 10 KHz*	*dB at 100 KHz*
1 Km	**−3**	**−5**	**−7**
10 Km	**−30**	**−50**	**−70**
15 Km	**−45**	**−75**	**−105**
20 Km	**−60**	**−100**	**−140**

12. As the Table 7.1 shows, for a specific maximum value of attenuation, the highest frequency decreases with distance. If we consider the bandwidth to start from zero, we can say that the bandwidth decreases with distance. For example, if we can tolerate a maximum attenuation of 50 dB (loss), then we can give the following listing of distance versus bandwidth.

Distance	**Bandwidth**
1 Km	100 KHz
10 Km	50 KHz
15 Km	1 KHz
20 Km	0 KHz

13. We can use Table 7.1 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.

14. See Table 7.2 (the values are approximate).

Table 7.2 *Solution to Exercise 14*

Distance	*dB at 1 KHz*	*dB at 10 KHz*	*dB at 100 KHz*
1 Km	**−3**	**−7**	**−20**
10 Km	**−30**	**−70**	**−200**
15 Km	**−45**	**−105**	**−300**
20 Km	**−60**	**−140**	**−400**

15. As Table 7.2 shows, for a specific maximum value of attenuation, the highest frequency decreases with distance. If we consider the bandwidth to start from zero, we can say that the bandwidth decreases with distance. For example, if we can tol-

erate a maximum attenuation of 50 dB (loss), then we can give the following listing of distance versus bandwidth.

Distance	**Bandwidth**
1 Km	100 KHz
10 Km	1 KHz
15 Km	1 KHz
20 Km	0 KHz

16. We can use Table 7.2 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 100 times for 100 KHz, which is unacceptable for most applications.

17. We can use the formula f = c / λ to find the corresponding frequency for each wave length as shown below (c is the speed of propagation):
    a. $B = [(2 \times 10^8)/1000\times10^{-9}] - [(2 \times 10^8)/\ 1200 \times 10^{-9}]$ = **33 THz**
    b. $B = [(2 \times 10^8)/1000\times10^{-9}] - [(2 \times 10^8)/\ 1400 \times 10^{-9}]$ = **57 THz**
18.
    a. The ***wave length*** is the ***inverse*** of the ***frequency*** if the propagation speed is fixed (based on the formula λ = 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.
19. See Table 7.3 (The values are approximate).

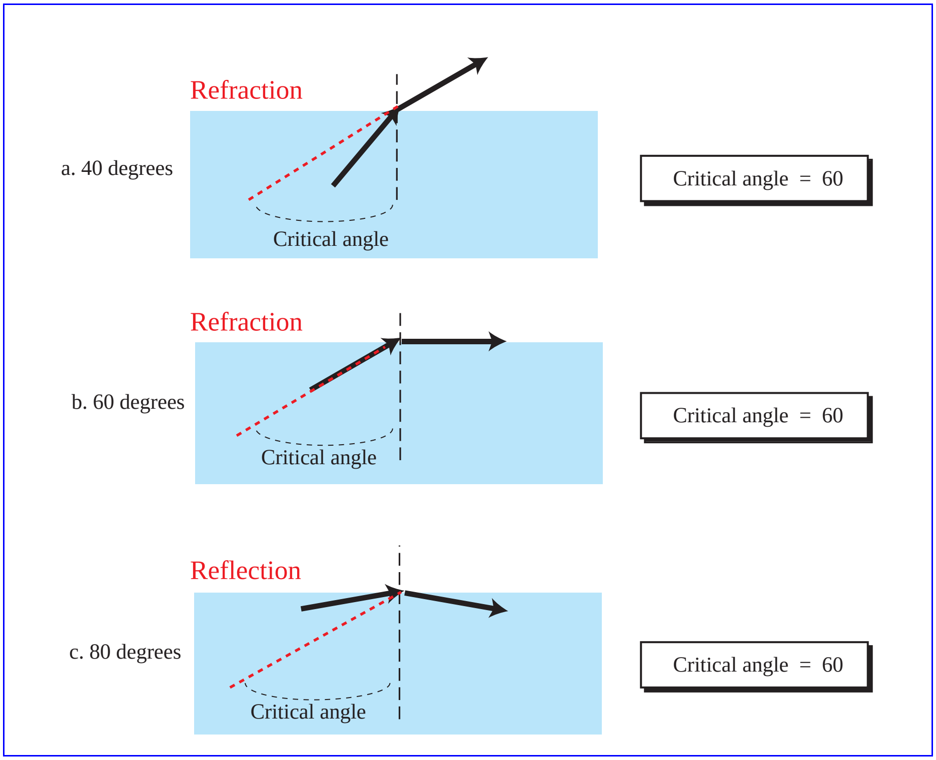
Table 7.3 *Solution to Exercise 19*

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**

20. The delay = distance / (propagation speed). Therefore, we have:
    a. Delay = $10/(2 \times 10^8)$ = **0.05 ms**
    b. Delay = $100/(2 \times 10^8)$ = **0.5 ms**
    c. Delay = $1000/(2 \times 10^8)$ = **5 ms**

21. See Figure 7.1.

Figure 7.1 *Solution to Exercise 21*



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.