CHAPTER 7

Transmission Media

7.1 REVIEW QUESTIONS

1. Power and voice: 0 to 3 KHz; radio communications: 3 KHz to 300 GHz; visible light: 430 THz to 750 THz.
2. Guided and unguided media
3. Guided media has physical boundaries, while unguided media is unbounded.
4. Twisted pair, coaxial, and fiber-optic cable
5. STP has a metal casing that prevents the penetration of electromagnetic noise.
6. Coaxial cable can carry higher frequencies than twisted pair cable and is less susceptible to noise.
7. When a light beam travels to a less dense medium, the angle of incidence is less than the angle of refraction (I < R). When a light beam travels to a denser medium, the angle of incidence is greater than the angle of refraction (I > R).
8.
   a. The beam bends toward the horizontal axis, and passes into the less dense medium (R > I).
   b. The refracted beam travels along the horizontal axis (R = 90 degrees).
   c. The light beam will be reflected back into the original medium (I = R).
9. Reflection may occur when a beam of light travels into a less dense medium and the angle of incidence is greater than the critical angle.
10. In multimode, multiple beams of light from one source travel through the core in different paths. In graded-index multimode, the core's density is not constant but is higher in the center and decreases gradually to a lower density at the edge. In single mode, a step-index fiber is used with a highly focused source of light.
11. 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.

12. Noise resistance, less signal attenuation, and higher bandwidth
13. Fiber optic cabling is expensive, installation/maintenance is difficult, and fragility
14. 3 KHz to 300 GHz
15. Surface, tropospheric, ionospheric, line of sight, and space propagation
16. Terrestrial microwaves require line of sight propagation, using repeaters (usually installed with each antenna) to increase the distance.
17. For constant communication, satellites have to move at the same speed as the earth.
18. During a conversation a mobile phone may move from one cell to another and the signal may become weak. In this case, the MTSO seeks a new cell to accommodate the communication. The MTSO changes the channel carrying the call. The process of handing the signal from the old channel to the new channel is called handoff.
19. Attenuation, distortion, and noise
20. Decibel measures the relative strength of two signals or a signal at two different points.
21. Throughput, propagation speed, and propagation time
22. Propagation time = distance / propagation speed
23. The wavelength is the distance a simple signal can travel in one period. Wavelength = propagation speed x period
24. The Shannon capacity determines the theoretical highest data rate for a channel.
25. Crosstalk occurs when one line picks up some of the signals from another line. One wire acts as a sending antenna, the other as a receiving antenna. Twisting and shielding can reduce it.
26. See Figure 7.20 in the text.
27. If a light beam is refractive, it would go through the cladding and get lost. To keep the beam within the core, it should be reflective.
28. The troposphere is the portion of the atmosphere extending outward approximately 30 miles from the earth surface and includes the stratosphere. It contains air and is used for the propagation of VLF, LF, MF, VHF and UHF signals. The ionosphere is the layer of the atmosphere above the troposphere. It contains free electrically charged particles (ions). The ionosphere is used to propagate HF signals.
29. In ionospheric propagation HF radio waves radiate upward into the ionosphere where they are reflected back to earth. The difference between the density of the troposphere and the ionosphere sends the radio waves back to earth.
30. The distance terrestrial microwaves can travel is limited by the curvature of the earth and surface obstacles because terrestrial microwaves require line of sight transmission.
31. In multimode step index, the light beam is bouncing back and forth down the channel until it reaches its destination. The number of bounces depends on the angle of incidence. Each bounce takes out some energy from the signal, which means that the signal needs to be regenerated more often if the angle of incidence is small (more bounces). In multimode grade index, the signal bounces less, therefore it can travel farther without regeneration. Single mode propagation uses almost horizon-

tal light beams due to the design of the fiber optic cable and the light source. These beams require less regeneration than the other two methods.

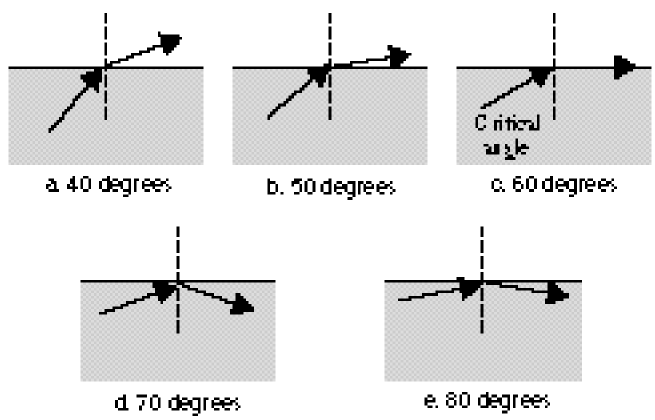
7.2 MULTIPLE CHOICE QUESTIONS

32. b	33. b	34. a	35. b	36. a	37. b	38. b	39. d	40. c	41. c
42. b	43. a	44. a	45. d	46. c	47. b	48. a	49. b	50. a	51. b
52. a	53. a	54. a	55. c	56. b	57. a	58. d	59. a	60. b	61. c
62. c	63. a	64. b	65. d	66. c	67. b	68. a	69. b	70. c	71. d
72. b	73. a	74. c	75. d	76. b	77. d	78. d	79. b	80. c	

7.3 EXERCISES

81. 22,287.83 miles / 186,000 miles per second = 0.120 s = 120 ms
82. See Figure 7.1.

Figure 7.1 *Exercise 82*



83. dB = 10 $\log_{10}$ (90 / 100) = –0.46 dB
84. –10 = 10 $\log_{10}$ (P_2 / 5) P_2 = 0.5
85. The total gain is 3 × 4 = 12 dB. The signal is amplified by a factor $10^{1.2}$ = 15.85.
86. 100 Kb / 5 s = 20 Kbps
87. 100,000 bits / 5 Kbps = 20 s
88. 400,000 km / 300,000 km/s = 1.33 s
89. 480 s × 300,000 km/s = 144,000,000 km

90. $2.9 \times 10^8 / 10^{12} = 0.0003$ m = 0.3 mm
The wavelength of infrared is longer than the wavelength of red because the frequency of the former is less than the frequency of the latter.
91. 1 μm × 5 = 5 μm
92. 2,000 km / 195,000 km/s = 0.01 s = 10 ms
93. $4{,}000 \log_2 (1 + 1{,}000) = 40$ Kbps (approximately)
94. $4{,}000 \log_2 (1 + 10 / 0.005) = 43{,}866$ bps