The Islamic University of Gaza

Faculty of Engineering

Computer Engineering Department

Data Communications ECOM 4314

Assignment # 2

(Chapter 3)

Solution

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Question 1: Choose the correct answer   **(10 Marks)**

1. What is the bandwidth of a signal that ranges from 1 MHz to 4 MHz?
   a. 4 MHz
   b. 1 KHz
   c. 3 MHz   (4M -1M)
   d. none of the above

2. Consider a noiseless channel with a bandwidth of 4 KHz. If we want to transmit 24 Kbps on this channel, the minimum number of signal levels we need is …….
   a. 4
   b. 6
   c. 8   (BitRate=2*Bw*$\log_2$ L=> 24k=2*4k*$\log_2$ L=> L=8)
   d. 12

3. Suppose that the spectrum of a noisy channel is between 4 MHz and 10 MHz, and SNRdB =15 dB. The maximum bit rate on this channel is approximately ……
   a. 4 Mbps
   b. 10 Mbps
   c. 15 Mbps
   d. 30 Mbps   (SNR=10^(15/10)=31.6 =>C=B*$\log_2$(1+SNR) => C=(10M-4M)*$\log_2$(32.6)
   e. 60 Mbps

4. If the bandwidth of a signal is 5 KHz and the lowest frequency is 52 KHz, what is the highest frequency?
   a. 5 KHz
   b. 10 KHz
   c. 47 KHz
   d. 57 KHz   (5k+52k)

5. A signal is measured at two different points. The power is P1 at the first point and P2 at the second point. The dB is 0. This means _____.
   a. P2 is zero
   b. P2 equals P1
   c. P2 is much larger than P1
   d. P2 is much smaller than P1

6. For a _____ channel, we need to use the Shannon capacity to find the maximum bit rate.
   a. noisy
   b. noiseless
   c. bandpass
   d. low-pass

7. Which of the following is/are correct about baseband and broadband transmissions?
   a. If the available channel is a bandpass channel, we can send a digital signal directly to the channel.
   b. A low-pass channel can be considered a bandpass channel with the lower frequency starting at zero.
   c. Broadband transmission of a digital signal is possible only if we have a lowpass channel.
   d. None of above.

8. For a _____ channel, we need to use the Shannon capacity to find the maximum bit rate.
   a. noisy
   b. noiseless
   c. bandpass
   d. low-pass

9. _____ describes the position of the waveform relative to time 0.
   a. Frequency
   b. Phase
   c. Amplitude
   d. Voltage

10. _____ is a type of transmission impairment in which the signal loses strength due to the resistance of the transmission medium.
   a. Attenuation
   b. Distortion
   c. Noise
   d. Decibel

Question 2: The Islamic University of Gaza has in mind to establish a digital library. This library contains 20 millions of books with 500 white pages and black text for each. For each page, the text covers 7inch×7inch and it represents by 250dpi×250dpi. Assume that one dot will be represented with one bit. **(4 Marks)**

a. What is the size in bytes of the storage disk required for this library?

(20*10^6*500*7*7*250*250)/8= 3.828125 *10^12 byte

b. The library might be accessed concurrently by 1500 users and they request a new page per minute. Calculate the data rate if the channel has a bandwidth of 100MHz.

1500 request a page   at   minute

1500*7*7*250*250   60s

    ?   1s   data rate= (1500*7*7*250*250)/60=76.56 bps

Question 3: Determine the possible Bit-rate and the number of Levels over a channel for these cases? **(6 Marks)**

a. BW = 2.4 kHz, noiseless channel with L=16.

$$N=2B log_2 L = 2*2.4K*log_2 16 =19.2Kbps$$

b. BW = 2.4 kHz, SNR = 20 dB.

$$SNRdb= 10 log_{10} SNR \quad so\ SNR=100$$
$$C= B log_2 (1 + SNR)= 2.4k*log_2 (1 + 100)= 16Kbps$$
$$N=2B log_2 L$$
$$16K=2*2.4*log_2 L \quad L=11 level$$

c. BW = 3.0 kHz, SNR = 40 dB.

SNRdb= $10 log_{10} SNR$ so SNR=10000
C= Blog_2 $(1 + SNR)$= 3k*log_2 $(1 + 1000)$= 39.86Kbps
N=2B$log_2 L$
39.8K=2*3*$log_2 L$ L=100 level

Question 4: The attenuation of a signal is -10dB. What is the final signal power if it was originally 5W?   **(2 Marks)**

$$-10 = 10 \log_{10}(P_2/5) \rightarrow \log_{10}(P_2/5) = -1 \rightarrow (P_2/5) = 10^{-1} \rightarrow P_2 = 0.5\text{W}.$$

Question 5: Suppose there is a 10Mbps microwave link between a geostationary satellite and its base station on Earth. Every minute the satellite takes a digital photo and sends it to the base station. Assume propagation speed of $2.4\text{x}10^8$ meters/sec, and the space between the satellite and its base station is 36000 Km.   **(4 Marks)**

a. What is the propagation delay of the link?

Propagation time= distance / propagation speed.

=36*10^3K /(2.4*10^8) =150ms

b. What is the bandwidth-delay product?

Bw delay product = tp*BW

=10M*150ms = 150Kbit

Question 6: What are the propagation time and the transmission time for a 2.5-kbyte message if the bandwidth of the network is 1 Gbps? Assume that the distance between the sender and the receiver is 12,000 km and that light travels at 2.4×10^8 m/s. **(4 Marks)**

$$\text{Propagation time} = \frac{12,000 \times 1000}{2.4 \times 10^8} = 50 \text{ ms}$$

$$\text{Transmission time} = \frac{2500 \times 8}{10^9} = 0.020 \text{ ms}$$

Question 7: A telephone normally has a bandwidth of 3000 Hz (300 to 3300 Hz) assigned for data communications. The signal-to-noise is usually 4095. What is the theoritical highest bit rate of the regular telephone line? **(4 Marks)**

$C = B \log_2(1 + \text{SNR}) = 3000 \log_2(1 + 4095) = 3000 \log_2 4096 = 3000 * 12 = 36,000$ bps.

Question 8: A signal goes from routers A, through B and C, and finally arrives at D. The signal loses 2 dB from A to B, again 5 dB from B to C, and loses 3 dB from C to D. What is the total gain or loss from A to D? **(2 Marks)**

SNR db= -2+5-3=0db
SNR=1

Question 9: What reasoning can you give to a non-technical person to explain why we need a modem to send data over telephone lines? What is the maximum bit rate possible to transmit data using base-band transmission over telephone line? **(4 Marks)**

Telephone subscriber lines are designed to carry voice (analog signal) with a limited bandwidth (frequencies between 0 and 4 kHz). Although this channel can be used as a low-pass channel, it is normally considered a bandpass channel. One reason is that the bandwidth is so narrow (4 kHz) that if we treat the channel as low-pass and use it for baseband transmission, the maximum bit rate can be only 8 kbps.

- The solution is to consider the channel a bandpass channel, convert the digital signal from the computer to an analog signal, and send the analog signal. We can install two converters to change the digital signal to analog and vice versa at the receiving end. The converter in this case, is called a modem, usually 56kHz. (modulator/demodulator).
As a conclusion modulation is needed because the BW of voice lines is 4kHz, and the BW of the used modem is 56kHz.