IT3031: Communication Systems Midterm Exam Date: April 24, 2008

1. Compare the difference between 'telecommunication' and 'data communication.' (5 pts)

   ANS: Telecommunication contains telephony, telegraphy and television which use analog or digital transmission. Data communication is the subset of telecommunication which use digital transmission.

2. Compare the difference between 'analog' and 'digit.' (5 pts)

   ANS: analog is transmission with continues signal and digital is presented by discrete signal.

3. Illustrate the topology of mesh, star, bus, and ring. Compare the merits and demerits of them. (10 pts)

   ANS:

   (1) mesh:

   advantage: use of dedicated links, robust, privacy or security, point-to-point makes fault isolation easy.

   disadvantage: related to the amount of cabling and the number of I/O ports, installation and reconnection are difficult, sheer bulk of the wiring can be greater than the available space can accommodate.

   (2) star:

   advantage: less expensive, easy to install, less cabling needs, robustness, fault isolation

   disadvantage: If the hub goes down, the whole system is dead.

   (3) bus:

   advantage: ease of installation, less cabling than mesh or star topologies.

   disadvantage: difficult reconnection and fault isolation signal reflection at the taps. The damage area reflects signal back in the direction of origin, creating noise in both direction.

   (4) ring:

   advantage: easy to install, add or delete a device requires changing only two connections. If one device does not receive a signal with a specified period, it can issue a alarm.

   disadvantage: unidirectional, a break in the ring can disable the entire network.

4. We measure the performance of a telephone line (4 KHz) of bandwidth). When the signal is 10V, the noise is 5mV. What is the maximum data rate supported by this telephone line? (5 pts)

   ANS: We have $4,000 \log_2(1 + 10/0.005) = 43,866$ bps.

5. The attenuation of a signal is -10dB. What is the final signal power if it was originally 5W? (5 pts)

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

6. We have a channel with 4 KHz bandwidth. If we want to send data at 100 Kbps, what is the minimum SNR_{dB}? What is SNR? (10 pts)

   ANS: We can use the approximate formula

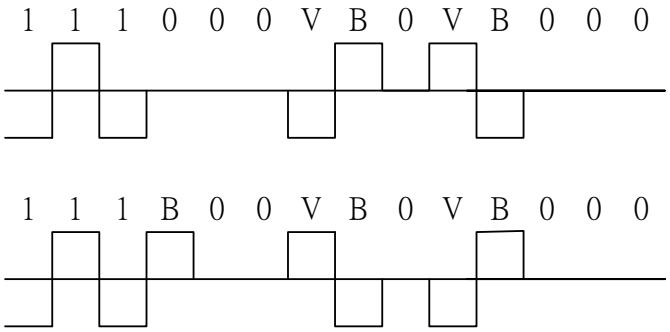
   C = B (SNR_{dB} /3) or $\text{SNR}_{\text{dB}} = (3\text{C})/\text{B}$

   We can say that the minimum

   $\text{SNR}_{\text{dB}} = 3 \times 100$ Kbps / 4 KHz $= 75_{\#}$

   This means that the minimum

   $\text{SNR} = 10^{\text{SNR}_{\text{dB}}/10} = 10^{7.5} \approx 31{,}622{,}776_{\#}$



7. What is the total delay (latency) for a frame of size 5 million bits that is being sent on a link with 10 routers each having a queuing time of 2μs and a processing time of 1 μs. The length of the link is 2000 Km. The speed of light inside the link is 2×10^8 m/s. The link has a bandwidth of 5 Mbps. Which component of the total delay is dominant? Which one does dominant the transmission time? (10 pts)

   ANS: We have
   Latency = processing time + queuing time + transmission time + propagation time. Processing time = 10×1 μs = 10 μs = 0.000010 s.
   Queuing time = 10×2 μs = 20 μs = 0.000020 s.
   Transmission time = 5,000,000 / (5 Mbps) = 1 s.
   Propagation time = (2000 Km) / (2 108) = 0.01 s.
   Latency = 0.000010 + 0.000020 + 1 + 0.01 = 1.010030 s.
   The transmission time is dominant here because the packet size is huge.

8. What is the result of scrambling the sequence 11100000000000 using one of the following scrambling techniques? Assume that the last non-zero signal level has been positive. (10 pts)

   a) B8ZS

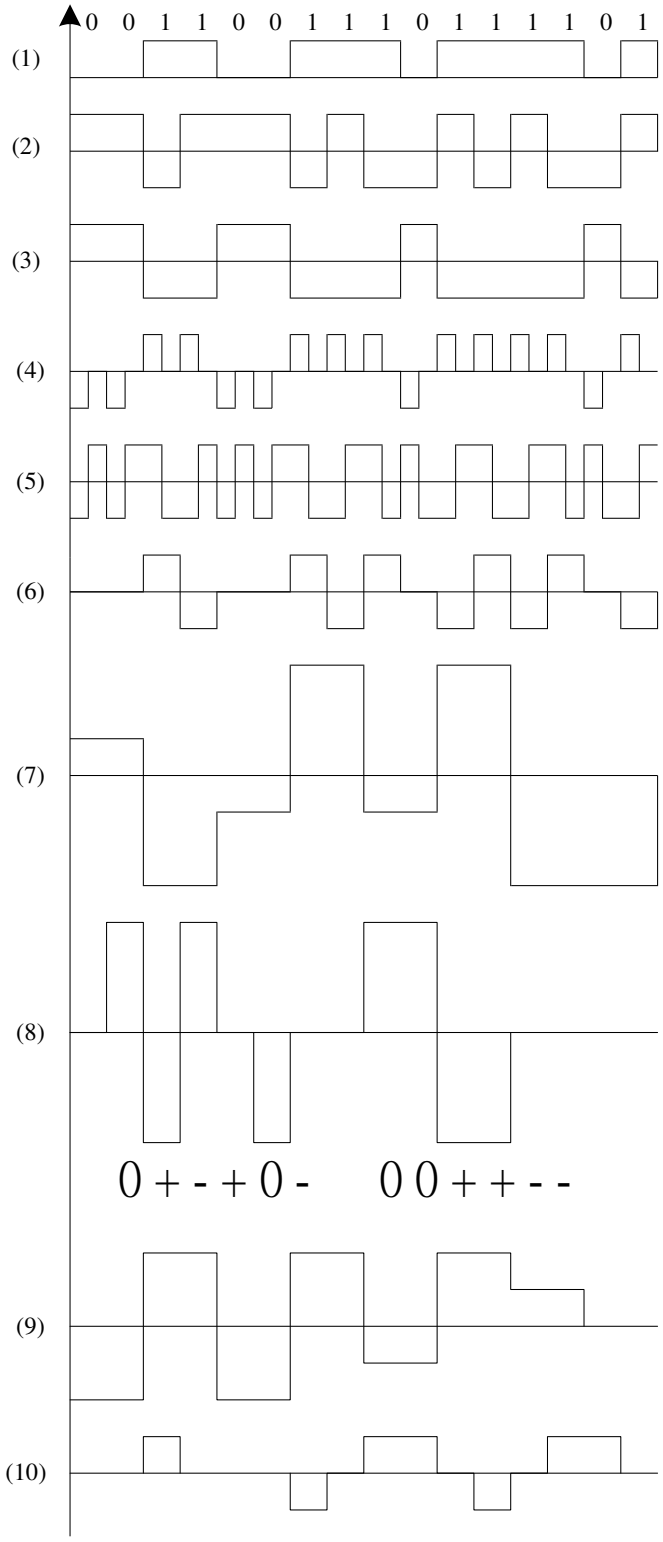
   b) HDB3 (The number of nonzero pules is odd after the last substitution)

   ANS:

9. Draw the data stream 0011001110111101 with graph of following schemes. (30 pts)

   (a) NRZ
   (b) NRZ-I
   (c) NRZ-L
   (d) RZ
   (e) Different Manchester
   (f) AMI
   (g) 2B1Q
   (h) 8B6T
   (i) 4D-PAM5
   (j) MLT-3

   ANS:


0 0 1 1 0 0 1 1 1 0 1 1 1 1 0 1
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
0 + - + 0 - 0 0 + + - -
(9)
(10)

10. An analog signal has a bandwidth of 20 KHz. If we sample this signal and send it through a 30 Kbps channel what is the SNR_{dB}? (10 pts)

    ANS: We can first calculate the sampling rate (f_s) and the number of bits per sample (n_b).
    $f_{\max} = 0 + 4 = 4$ KHz $\rightarrow f_s = 2 \times 4 = 8000$ samples/sec.
    We then calculate the number of bits per sample.
    $n_b = 30000/8000 = 3.75$
    We need to use the next integer $n_b = 4$. The value of SNR_{dB} is
    $\text{SNR}_{\text{dB}} = 6.02 \times n_b + 1.72 = 25.8_{\#}$