1. a. Following the logic in Tannenbaum with respect to Figure 2-2, sending digital data over a voice-grade telephone circuit, if the signals are instead encoded with only 2 bits/sample (i.e. 4 levels), what will be the first harmonic and the # harmonics sent over a voice grade line at: i) 4800; ii) 9600; iii) 19,200 bps? 
b. Why might you use only 2 bits (4 levels) and not 3 bits (8 levels) for this?

2. Suppose symbols are sent on a noiseless 4-k Hz channel at rate of one symbol every 0.50 msec. If the symbols each encode 4 bits, what is the maximum data rate for this channel? What if the symbols each encode 8 bits? What is the upper limit on the data rate for this (noiseless) channel?

3. Suppose a data channel can send data at 10 Mbps, and the channel has a signal/noise ratio of 1000. If its bandwidth cannot be changed, how much improvement in signal/noise ratio is required to get this channel to send at the rate 100Mbps? (Equivalently, assuming the noise is unchanged, how much more signal power is required to get the rate to 100Mbps using the same bandwidth?)

4. Suppose a channel has a signal-to-noise ratio of 30db, and a bandwidth of 4 kHz. What is the maximum data rate possible for this channel?

5. What is the Nyquist rate for a 4 kHz channel with 2 levels of encoding?

6. Interpret your answers for 4. and 5. with respect to each other. Can the Shannon rate be achieved with 2 levels of encoding?

7. A T1 carrier provides 1.544 Mbps. If you are to deliver that T1 service over a channel with bandwidth of 100-kHz, what signal-to-noise ratio is required?

8. FDM (Frequency Division Multiplexing) splits a channel up among each of its users. If the users are sending encoded video signals, and each requires a bandwidth of 2 MHz. If a guard band between these is 200 k Hz, how many of these can fit into an data channel of 100 MHz bandwidth?

9. From the data provided on the T1 setup in the Network Lab, characterize the signal as it goes through each 1K feet of Cat-5 cable. Plot the attenuation vs. distance. What can you observe about the noise as the distance increases? What is your “guestimate” of the distance this signal can travel on Cat-5 cable before it is not decodable?