1. Signals sent over long distances must be amplified to restore them to the proper intensity level. Why is it better to send digital encoding of analog signals (e.g. audio), vs. sending the analog signal?

2. a. Give at least two reasons why fiber is preferable to UTP for a data link

   b. Give at least two reasons why most LANs still use UTP.

3. The (POTS) telephone sends voice (after the local loop) as digital data. The analog signal is limited to (approximately) a 4 KHz bandwidth, and is sampled at 8 KHz.

   a. Why is it sampled at 8 KHz?

   b. If the samples are quantized to 256 different levels, what is the bit rate required for sending this digital signal?

   c. What is the bandwidth required for sending this digital signal when encoded in two levels?

   d. If a new VoIP (Voice over IP) phone system wanted to give better fidelity to voice traffic, and chose to deliver up to 8 KHz of (analog) bandwidth, how many bits per second would it use for this voice channel (again using 256 quantization levels)?

   e. How might it achieve this still using the same digital channel used for the POTS as found in “c”?

4. Suppose your computing infrastructure has a mail server, file server and a print server all attached to the server LAN, and your machine (and others) attached to departmental LANs. There is a bridge connecting the server LAN and the departmental LANs. Suppose you change departments, and move your machine from port 2 of LAN “A” to port 7 of LAN “D”. What happens now to frames sent (for example) by the mail server to your machine? How / when does the bridge fix its table?
5. We have shown that the efficiency of an Ethernet, due to its random access scheme, is far below 100%. A proposal for a different protocol is as follows. Suppose there are \( N \) stations using the LAN. Time on the network is divided equally among each of the stations, and they take turns on the LAN according to their allocated time slot (time division multiplexing). It is claimed that this protocol will achieve 100% efficiency. Is this true? Why is this (is or is not) a good protocol for a LAN?

6. a. Why did 802.11 require a different protocol than 802.3 (Ethernet) for controlling access to the channel?

b. If 802.11 used the same frames as Ethernet frames, what would have been the consequences?

7. Rank the link layer protocols \textit{Stop-and-Wait (S)}, \textit{Go back N (G)}, and \textit{Selective Repeat (R)}, for a link with noise (not error-free) and of non-negligible length, according to:
   a. utilization of link bandwidth
   b. buffering required of the
      i. sender
      ii. receiver

8. For a 10 Mbps Ethernet LAN the 802.3 specification allows “multiple cable segments and multiple repeaters, but no two transceivers may be more than 2.5 km apart and no path between any two transceivers may traverse more than four repeaters” [text, pg.: 274]. Later [text, pg. 277] we find: “500 bits is the smallest frame that is guaranteed to work. …this number was rounded up to 512 bits or 64 bytes.”
   a. Show how this frame size is determined.

b. In specifying this frame size, how much time was allowed for delays in the repeaters?
Note: for velocity of propagation in copper conductors, use \( v = 2 \times 10^8 \) m/sec.