1. Course Handout: Topic 2 Questions 4f (circuit/packet switching); Topic 3 Question 9 (CRCs).

   Hint for 9c: Formulate the CRC computation as a series of XOR and shift operations and then design the corresponding circuit

2. (a) Sketch the signal on a wire if the bit sequence 11111010 is to be transmitted using Manchester Coding (Slide 11 in Topic 3). Note: It will be easier to make this sketch if you draw a reference clock signal.

   (b) The receiver of a Manchester-coded signal only receives the coded signal (and not the clock). Suppose the receiver starts listening to the signal at some arbitrary time after the signal has started arriving. Explain how the receiver can identify which edges in the received signal are the ones that correspond to data bits.

3. An office has an (Internet) access link rated at 100 Mbps full-duplex. Each user requires 10 Mbps when transmitting and each user is active 10% of the time.

   (a) Initially a static allocation of bandwidth is made for each user. How many users can the access link support?

   (b) The office actually has 25 people who need to use the Internet. As a result, they decide that the static allocation is not particularly efficient and decides to use a packet-switched approach instead. What is the probability that *exactly* 10 users are transmitting at any given moment?

   (c) What is the probability that more than 10 users are transmitting at any given moment?

4. First, define one 'bit-time' as the time it takes for a network interface to place a bit onto a link. Two hosts, A and B, are connected by a link over some distance. On this link, it takes 340 bit-times for data to propagate from one host to the other (but the hosts have no way of knowing this). Messages on the link have a size of 576 bits.

   Consider the case where at time 0, A sends a single message. At some later time t, B begins transmitting a message of its own.

   (a) For what values of t will there be a collision?

   (b) For what values of t will there be a collision that A is not aware of?

(c) For what values of t will there be a collision that neither A nor B is aware of?

(d) How do your answers change if A and B are separated by 1000 bit-times?

5. Optional: "The case of the 500-mile email" (https://www.ibiblio.org/harris/500milemail.html) is an entertaining story about latency and networks.