1. Why does circuit switching waste bandwidth if the traffic is bursty? Under what traffic conditions is circuit switching optimal?

2. You may have noticed that at busy events (e.g., concerts, sporting events, etc.) the Internet connection on your mobile device can become unstable or stop working entirely. Provide two hypotheses, with each one focusing on a different part of the network, for why this degradation in performance is happening.

3. Give two examples of multiplexing in a real-world system that is *not* related to computing: one that behaves more like a circuit-switched network and that behaves more like a packet-switched network. In each example, describe the (a) characteristics that make it more packet/circuit-like, (b) explain what is being multiplexed, and (c) how overloading of the underlying resource manifests itself.

4. (a) What does it mean for computer networks (or any system, for that matter) to have a "narrow waist"? Give one reason why having a narrow waist is good feature for a system. Give one reason where having a narrow waist might be bad for a system.

   (b) The layered design of the Internet is often cited as a major reason why there are a plethora of applications that are able to run over the Internet. How does this feature of the Internet help developers of new applications?

5. An office has an Internet link with a capacity of 120 Mbps full-duplex. Each user requires 15 Mbps when transmitting and each user is active 15% of the time.

   (a) Initially a static allocation of bandwidth is made for each user. How many users can the 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 statistical approach instead. What is the probability that *exactly* 8 users are transmitting at any given moment?

   (c) What is the probability that more than 8 users are transmitting at any given moment?

6. (a) Why will a physical channel that only passes sinusoids with frequency f Hz and lower have trouble transmitting a digital signal (i.e., only high and low pulses) with a bit rate greater than f bits per second?

(b) If we allow the transmission of analog signals, a channel with no noise can potentially transmit a great deal of information even if the frequencies it can pass is very limited. Explain how one would use a noise-free channel to send information.