1. Wireless channels.
   a. Describe the following types of wireless channel impairments?
      i. path loss

      Path loss is the reduction in signal strength/power density of an electromagnetic wave as it travels through matter.

      ii. multipath propagation

      Multipath propagation is the propagation phenomenon of taking paths of different lengths between sender and receiver and results in blurring of received signal at the receiver and occurs when portions of the electromagnetic wave reflect off objects and ground.

      iii. interference from other sources

      Interference from other sources occurs when other sources are also transmitting in the same frequency range as the designated wireless channel.

   b. As a mobile node gets farther and farther away from a base station, what are two actions that a base station could take to ensure that the loss probability of a transmitted frame does not increase?

      1. increase transmission power
      2. reduce transmission rate.

2. After successfully transmitting a frame in the CSMA/CA protocol, a wireless node needing to also send additional frames must wait for a randomly chosen binary exponential backoff period. What rationale might the designers of CSMA/CA have had in mind by having such a wireless node not transmit a successive frame immediately (even if the channel is sensed idle)?

   There is case that if A is sending out a frame, but B also plans to send out a frame the period then B will sense the channel is busy, and therefore choose a random backoff value. Rationale is to optimize transmission and fairness. The designer can make A functions the same way as B does in the previous case which results in if A also plans to send out a frame the period then A will sense the channel is busy, and therefore choose a random backoff value. The designer can also make A waits for a period of time before transmitting a second frame when B is stuck in backoff mode.

3. Suppose an 802.11b station is configured to always reserve the channel with the RTS/CTS sequence. Suppose this station suddenly wants to transmit 1,000 bytes of data, and all other stations are idle at this time. As a function of SIFS and DIFS, calculate the time required to transmit the frame and receive the acknowledgment. Note that you should ignore propagation delay and assume no bit errors for this particular problem.

   The bit amount of a frame excluding data = 34 bytes = 272 bits

The time to transmit 1,000 bytes frame of data = (8272 bits)/ (11 Mbps) = 752 usec.

The bit amount of a RTS frame = 14 bytes = 112 bits
The time to transmit a RTS frame = (112 bits)/ (11 Mbps) = 10.2 usec.

The bit amount of a CTS frame = 12 bytes = 96 bits
The time to transmit a CTS frame = (96 bits)/(11 Mbps) = 8.7 usec

The bit amount of a ACK frame = 12 bytes = 96 bits
The time to transmit a ACK frame = (96 bits)/(11 Mbps) = 8.7 usec

DIFS + RTS + SIFS + CTS + SIFS + FRAME + SIFS + ACK = DIFS + 3SIFS + (10.2 + 8.7 + 752 + 8.7) usec = DIFS + 3SIFS + 779.6 usec

4. Mobile IP.
   a. Assuming that mobile IP is being used, what effect will mobility have on end-to-end delays of datagrams between the source and destination?

      The mobility needs in-direct routing. The datagrams must be forwarded to the home agent, then home agent will add to the datagram, then datagrams will be sent to the mobile, which result in the longer delay than direct routing. It is possible to have direct routing for which the delay time will depend on the delay of the path segments.

   b. Consider two mobile nodes in a foreign network having the same foreign agent. Is it possible for the two mobile nodes to use the same care-of address (COA) in mobile IP? Explain your answer

      It is possible for the two mobile nodes to use the same care-of address (COA) in mobile IP. If the care-of-address (COA) is the address of the foreign agent, then the address would be the same. The foreign agent would decapsulate the datagram and determines separate address of the mobile would need to be used to send out datagrams separately to their own destination.

5. What are three different approaches that can be taken to avoid having a single wireless link degrade the performance of an end-to-end transport-layer TCP connection?

   1. Local recovery = Bit errors recovery at the wireless link

   2. TCP sender awareness of wireless links = Enabling of the TCP sender to aware of the wireless link where ordinarily it would not be.

   3. Split connection = Splitting the sender and receiver down into 2 transport layer connections (1 from the mobile host to the wireless AP, 1 from the AP to the end point.)