1. (5 points) The images above illustrate two collision problems associated with wireless communication. In the image on the left, the two terminals both attempt to communicate with the access point between them simultaneously, since neither terminal is within range of the other, which prevents them from sensing the other’s transmission. This results in the access point experiencing signal interference and is unable to decipher either message. This problem is usually resolved by means of a handshaking protocol in which each terminal must send a small request-to-send (RTS) frame to the access point, which in turn selects one of the terminals to which it will respond with a clear-to-send (CTS) message.

In the image on the right, the left access point is communicating with the left terminal, and the right access point wants to communicate with the right terminal, but believes that it is prevented from doing so because the right access point senses the left access point’s communication and concludes that its use of the channel is blocked. In point of fact, the left access point’s transmission should not interfere with the right access point’s transmission since it is out of range of the right terminal. Explain how the use of RTS and CTS frames can also resolve this problem.

2. (5 points) To avoid the expense associated with fixed-wire links, some networks use a wireless system by which radio or microwave signals are transmitted from an endstation, across a network of base stations, and ultimately to a receiving station. The base stations are usually arrayed in a cellular pattern, as demonstrated in the two diagrams below.

In the diagram on the left, the available spectrum of frequencies is divided into three equal bands, F1, F2, and F3, and each base station transmits only within its designated band. In the diagram on the right, the spectrum is divided into seven such bands. Explain the relative advantages of the three-band and the seven-band approaches.
3. (5 points) IEEE 802.11 (Wireless LAN) uses an exponential backoff algorithm similar to that in IEEE 802.3 (CSMA/CD) whenever a transmitted frame is not acknowledged. In addition to the random backoff, however, wireless 802.11 stations add an additional amount of delay prior to transmitting, called an initial interframe space (IFS). There are three types if IFS values: large, medium, and small. The large IFS value is used for retransmitting asynchronous frames, while the medium IFS value is used for retransmitting time-critical frames. Give an example of the kind of high-priority frame for which a wireless station would use the smallest IFS value.

4. (5 points) IEEE 802.11n wireless networks use a Multiple-Input/Multiple-Output (MIMO) approach, in which service access points utilize multiple antennas to improve data rates. One MIMO approach, pictured at upper right, is to reinforce its signal by sending identical copies of the signal on each antenna, adjusting each antenna’s output by determining the path it takes to get to the receiver, which then receives a fortified version of the incoming signal. An alternative approach, pictured at lower right, is to multiplex the outgoing signal, with each antenna on the service access point transmitting a separate portion of the signal, which is combined back into the original, higher bandwidth signal at the receiver. While the latter approach certainly has a speed advantage, explain what additional drawback is associated with the latter approach.

5. (5 points) IEEE 802.11p wireless networks have been designed for inter-vehicle communication between automobiles, such as collision avoidance systems. Explain why the IEEE 802.11p plan to use CSMA/CD as its MAC sublayer protocol is inappropriate.

6. (5 points) Consider a scenario in which two Internet service providers (ISPs) are providing Wi-Fi access to the same café, each operating its own access point (AP) and having its own block of IP addresses. If the ISPs accidentally configure their APs to the same channel, explain the extent to which the 802.11 protocol will still be able to operate. Specifically, discuss what happens when two stations, each associated with a different ISP, attempt to transmit simultaneously. Also, explain how the situation would change if each AP operated over a different channel.

7. (5 points) Given a time-slotted WiMAX network containing a base station and four nodes that are reachable from the base station on the downstream channel. Node A is reachable at 128 Mbps, node B is reachable at 32 Mbps, node C is reachable at 8 Mbps, and node D is reachable at 2 Mbps. The time slots are of equal duration and the base station may send to any node during any time slot. If the base station takes the totally unfair approach of only transmitting to node A, then it can transmit at the maximum rate of 128 Mbps. However, if there is a fairness requirement that each node must be allotted the same amount of data, calculate the average rate at which the base station can send to the nodes.

8. (5 points) Consider an alternative Mobile IP approach in which mobile users would be able to maintain their IP addresses as they move among foreign networks. The foreign network would merely advertise the new foreign route to the mobile user and depend on the existing IP routing infrastructure to propagate this information throughout the Internet so any potential correspondents will be able to directly access the mobile user without routing through the home network. Explain how much time will transpire after this advertising begins before datagrams will be routed to the new foreign network.

9. (5 points) Non-voice communication on wireless LAN systems tends to be packet-based, as opposed to the circuit-based approach of transmitting voice during cellular telephone conversations. Explain the advantages and disadvantages of the packet-based and circuit-based approaches in this context with respect to the mobile handoff that occurs at a cell’s border.

10. (5 points) The congestion control mechanism in Asynchronous Transfer Mode (ATM) operates under the assumption that timeouts are caused by stations exceeding their negotiated transmission rates. As a result, ATM has sending stations reduce their transmission rates whenever timeouts occur. Explain why this approach to congestion control would be inappropriate for wireless networks.