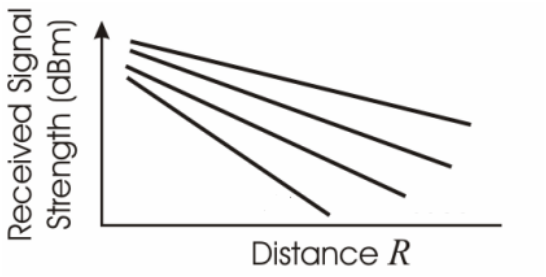
Contemporary Topics in ECE 55:195, Spring 2005
Introduction to Wireless Sensor Networks
Review Questions

1. Explain how advances in MEMS have contributed to the development of WSNs (2 points).
2. List and briefly explain the purpose of four building blocks of a mote. (4 points)
3. Briefly explain the purpose the OS on a WSN node (2 points).
4. Name and briefly explain the technological, scientific, and cultural developments that have contributed to the development of WSNs (4 points).
5. What is TinyOS? (2 points).
6. Explain (to a non-expert) what a mote is (3 points).
7. Name and explain the differences (3 points) and similarities (2 points) between the concept of a WSN and traditional telemetry.
8. Explain what the Argos system is (2 points).
9. Explain what the acronym SCADA stands for (2 points).
10. True or false—wireless fleet management is an example of WSNs (1 point).
11. Explain what the term "ISM" means (2 points).
12. What does the term "LOS" in the context of WSNs mean? (1 point).
13. What does the term "WSN" mean? (1 point).
14. True or false—Visual LOS implies RF LOS. (1 point).
15. A 1-km 2.4 GHz link has two antennas that are 2 m above the ground. Do we have LOS? "Yes" of "No" will not suffice, motivate your answer with a diagram or computations or both (5 points).
16. True of false—In free space RF power loss ~$1/R^2$ but when the transmitter and receiver is close to the ground, the loss can be ~$1/R^4$ (2 points).
17. In free space RF power loss ~$1/R^2$ but when the transmitter and receiver are close to the ground, the loss can be ~$1/R^{4.}$ Using a figure and short paragraph, explain why this is so (4 points).
18. What does the term "RSSI" stand for? (1 point). How is it used in WSNs? (2 points)
19. True or false—ISM bands are unregulated (1 point).
20. Explain with a simple sketch and paragraph how multipath propagation can diminish or enhance radio propagation (3 points).
21. What does the term "BER" stand for? (1 point).
22. A manufacturer claims its radio can make reliable reception if the received power is -105 dBm. How many mW is this? (2 points). Are you impressed?
23. What does the term "TDMA" stand for? (1 point).
24. Explain in a short paragraph what FDMA is (3 points).
25. Explain (to grandma) what Spread Spectrum communication is. (3 points)
26. What do the terms "S/N" and "SNR" mean? (1 point)
27. What are the common units of SNR? (1 point).
28. True or false – everything else being equal, RF path loss are higher at 2.5 GHz than at 900 MHz (1 point)
29. Estimate the path loss in dB at 900 MHz in an ***indoor*** environment. There are two floors are six walls between transmitter and receiver (5 points).

30. The antennas of a 2.4 GHz RF link are 1 m above the ground, and are 100 m apart. Is the path loss ~ $1/R^2$ or ~ $1/R^4$ in open environment? (3 points). Is the communication LOS? For both questions, Yes" of "No" will not suffice; motivate your answer with a diagram or computations or both.
31. A simple RF path loss model is *Received Power* = $KR^{-n,}$ where R is the distance between transmitter and receiver. What is n for an urban, suburban, free-space, and outdoor environment? (4 points).
32. A simple RF path loss model is *Received Power* = $KR^{-n,}$ where R is the distance between transmitter and receiver. This is depicted below. Label the 4 graphs appropriately with "urban", "suburban", "free-space", and "open-area" environment (4 points).



33. True or false—with respect to WSN MACs, effective collision avoidance is less important than fairness (1 point).
34. Explain why, with respect to WSN MACs, effective collision avoidance is more important than fairness (4 points).
35. Describe and elaborate briefly (three sentences) what we mean by the term "latency" as an attribute of a WSN MAC (3 points)
36. True or false—channel utilization is a crucial attribute of a WSN MAC (1 point).
37. Explain why channel utilization is not crucial attribute of a WSN MAC (3 points).
38. True or false—energy waste from collisions are less in contention MAC protocols than in scheduled MAC protocols (1-point).
39. List three scheduled MAC protocols (3 point).
40. True or false—in WSN where low-power, short range radio transmission is used, idle listing contributes very little to the energy consumption budget of a node (1 point)
41. Briefly explain the term *idle listening* in WSNs (3 points).
42. One major issue in TDMA MAC protocols that of *limited scaling*. Explain this statement in a 5-6 sentence paragraph (3 points).
43. Describe the LEACH MAC protocol (5 points).
44. Describe the Sohrabi & Pottie MAC protocol (5 points).
45. What is the fundamental purpose of a MAC protocol? (2 point).
46. Briefly describe *channel probing* in MAC protocols (e.g., the PAMAS MAC protocol). List disadvantages.
47. True or false—without adaptive listening latency in S-MAC is linear with the number of hops (1 point).
48. In a 5-6 sentence paragraph, contrast *application-level message passing* with *MAC fragments*. Explain why this is relevant in WSNs. (4 points).

49. Explain how application-level message passing is implemented in S-MAC (4 points).
50. True or false—CSMA is an example of a contention-based MAC protocol. (1-point)
51. Explain the difference between non-persistent, 1-persistent, and *p*-persistent CSMA (3 points).
52. What is the hidden-terminal problem as it relates to CSMA in WSNs? Use a figure to explain. (3 points).
53. What are RTS and CTS packets? (4 points).
54. Explain how handshaking is used to reduce collisions in CSMA. (4 points).
55. What are "beacons" as it relates to CSMA.
56. Explain the advantage of adding the message duration to *each packet* in S-MAC. (3 points).
57. What does "S-MAC" stand for? (1-point).
58. Explain in a paragraph what frequency-hopping spread spectrum is. (3 points).
59. What are orthogonal codes? Give an example of two orthogonal codes (3 points).
60. Explain in 2-3 sentences why spread spectrum techniques can provide better channel utilization than conventional (e.g., AM, FM) techniques (2 points).
61. List an briefly explain four advantages of spread spectrum communication (4 points).
62. What is a disadvantage of spread spectrum modulation? (1-point).
63. True or false – CDMA can be seen as an example of what is known a direct sequence spread spectrum? (1-point)
64. What are "FSK" and "OOK"? Use simple figures to explain. (4 points).
65. Show that the following codes are orthogonal (4 points):

C1 =	1	1	1	1
C2 =	1	-1	1	-1
C3 =	1	1	-1	-1
C4 =	1	-1	-1	1

66. The output from a CDMA receiver is "1 2 2 1 1 0" which contains messages from two transmitters. The spreading codes are:

C1 =	1	1
C2 =	1	-1

Decode the two messages (4 points).

67. Write a short (5 sentence) paragraph contrasting the needs and resources available in WSN as opposed to, say, the Internet. (5 points).
68. Explain the statement "When routing a packet in a WSN, more hops increase delay, but the advantage is that it increases energy efficiency for the WSN as a whole"
69. Write a 6-7 sentence paragraph explaining the term "routing on a curve." (5 points).
70. Write a paragraph explaining the term "convex perimeter routing" (5 points).

71. True of False – a major disadvantage of perimeter routing in WSN is that path construction require knowledge of the global topology (1 point).
72. With the aid of a figure, explain how a greedy forwarding strategy can result in a packet being stuck at a node in a WSN. (2 points).
73. Below is a connectivity graph for a WSN. (a) Planerize it using the RNG method. (b) Planerize it using the Grabriel method.

(figure goes here)

74. True or False – a problem with "Routing on a Curve" is that each node must know the location of all nodes along the routing path. (1 point).
75. Write a short (5 sentence) paragraph explaining what Trajectory-Based Routing is. (5 points).