Homework #4: Due April 1, 2003
5 Points Each

Problem 4.2
A group of N stations share a 56 kbps pure ALOHA channel. Each station outputs a 1000 bit frame on average of once every 100 sec, even if the previous one has not yet been sent (e.g., the stations can buffer outgoing frames). What is the maximum value of N?

With pure ALOHA the usable bandwidth is $0.184 \cdot 56$ kbps = 10.3 kbps.
Each station requires 10 bps, so $N = 10300/10 = 1030$ stations.

Problem 4.5
A large population of ALOHA users manages to generate 50 requests/sec, including both originals and retransmissions. Time is slotted in units of 40 msec.
(a) What is the chance of success on the first attempt?
(b) What is the probability of exactly k collisions and then a success?
(c) What is the expected number of transmission attempts needed?

(a) With $G = 2$ the Poisson law gives a probability of e^{-2}.
(b) $(1 - e^{-G})^k e^{-G} = 0.135 \cdot 0.865^k$.
(c) The expected number of transmissions is $e^G = 7.4$.

Problem 4.6
Measurements of a slotted ALOHA channel with an infinite number of users show that 10 percent of the slots are idle.
(a) What is the channel load, G?
(b) What is the throughput?
(c) Is the channel underloaded or overloaded?

(a) From the Poisson law again, $P_0 = e^{-G}$, so $G = -\ln P_0 = -\ln 0.1 = 2.3$.
(b) Using $S = Ge^{-G}$ with $G = 2.3$ and $e^{-G} = 0.1$, $S = 0.23$.
(c) Whenever $G > 1$ the channel is overloaded, so it is overloaded.

Problem 4.9
A LAN uses Mok and Ward's version of binary countdown. At a certain instant, the ten stations have the virtual station numbers 8, 2, 4, 5, 1, 7, 3, 6, 9, and 0. The next three stations to send are 4, 3, and 9, in that order. What are the new virtual station numbers after all three have finished their transmissions?

Increasing virtual station number has higher precedence:
When station 4 sends, it becomes 0, and 1, 2, and 3 are increased by 1. When station 3 sends, it becomes 0, and 0, 1, and 2 are increased by 1. Finally, when station 9 sends, it becomes 0 and all the other stations are incremented by 1. The result is 9, 1, 2, 6, 4, 8, 5, 7, 0, and 3.

Decreasing virtual station number has higher precedence:
8245173690
7294163580 after 4 sends
6283159470 after 3 sends
6283159470 after 9 sends

Problem 4.10
Sixteen stations, numbered 1 through 16, are contending for the use of a shared channel by using the adaptive tree walk protocol. If all of the stations whose addresses are prime numbers suddenly become ready at once, how many bit slots are needed to resolve the contention?

Stations 2, 3, 5, 7, 11, and 13 want to send. 11 or 13 slots are needed, with the contents of each slot being as follows: (2 possible solutions). Note that 1 is omitted as a prime number for the solutions presented.
Solution #1 (depth first):
slot 1: 2, 3, 5, 7, 11, 13
slot 2: 2, 3, 5, 7
slot 3: 2, 3
slot 4: 2
slot 5: 3
slot 6: 5, 7
slot 7: 5
slot 8: 7
slot 9: 11, 13
slot 10: 11
slot 11: 13

Solution #2 (breadth first):
slot 1: 2, 3, 5, 7, 11, 13
slot 2: 2, 3, 5, 7
slot 3: 11,13
slot 4: 2,3
slot 5: 5,7
slot 6: 11
slot 7: 13

slot 8: 2,3
slot 9: 5,7
slot 10: 2
slot 11: 3
slot 12: 5
slot 13: 7

Problem #6
Sketch the Manchester encoding for the bit stream: 0001110101
Sketch the differential Manchester encoding for the same bit stream.
Assume that the line is initially in the low state.

Manchester encoding
01|01|01|10|10|10|01|10|01|10

Differential Manchester encoding
01|01|01|10|01|10|10|01|01|10