Electrical, Computer, and Systems Engineering

ECSE 4760: Computer Communication Networks

Homework set 5: Due Tuesday, November 16 (Wednesday, November 21 for tape delayed students)

Notes:

1. Be brief.
2. **SUBMIT THIS HOMEWORK USING WEBCT DROP BOX.**
3. 4000 level students need to answer only Homework Problems 1, 2 3 and 4.
4. 6000 level students need to answer all questions.
5. All papers for the reading assignment are available from the course web page.

Homework Problems

1. Consider an experiment where a biased coin is tossed till a head is obtained. Successive tosses of the coin are independent. In any toss, the probability the we get a head is p and the probability that we get a tail is $1-p$. (30 pts)

(a) What is the probability that we have to toss the coin 3 times before a head is obtained? Generalize it to find the probability that we have to toss the coin i times before the first head is obtained.

(b) Now suppose in the first three tosses, we got a tail in each toss. Given that the first three tosses resulted in all tails, what is the probability that we have to toss the coin another three times before we get the first head?

(c) Is this process memoryless? In other words, can you say

$$P[i \textit{ more} \text{ tosses till first head} \mid j \text{ tosses without a head}] = P[i \text{ tosses till first head}]$$

2. Consider a transmission link with a finite buffer modeled as an M/M/1/N queueing system where N is the total number of buffer slots. Assume packet arrivals with rate $\lambda = 25$ packets/sec and fixed link capacity $C = 28,800$ bits/sec. Approximate the packet length distribution by an exponential with mean packet size of $L = 1000$ bits/packet. Compute the smallest buffer size, N, which yields a blocking probability of less than 10^{-5}. (20 pts)

3. Consider a transmission link with fixed link capacity $C = 1.5Mb/s$, $\lambda = 750$ packets/sec and <u>mean</u> packet length $L = 1000$ bits/packet. Using the Pollaczek-Khinchine (P-K) formula, compute the average delay ($E[T]$) for the following three cases

(a) All packets have the same length ($\sigma^2 = 0$).

(b) The packet length distribution is exponential.

(c) The variance of the service time is $\sigma^2 = 16 \times 10^{-6}$.

(25 pts)

4. Suppose we want to transmit the message 11001001 and protect it from errors using the CRC code 1001 (r=4).

(a) Determine the message that is transmitted.

(b) Suppose the leftmost bit of the message is inverted due to noise on the transmission link. What is the result of the reciever's CRC calculation? How does the reciever know that an error has occured?

(25 pts)

Additional questions for 600 level students

1. Consider a M/M/1 queueing system in which

$$\lambda_k = \begin{cases} \lambda & 0 \le k \le K \\ 2\lambda & k > K \end{cases}$$

$$\mu_k = \mu \qquad k = 1, 2, \cdots$$

(a) Find the equilibrium probabilities p_k for the number in the system.

(b) What is the condition for stability in terms of λ and μ?

(30 pts)