KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
COLLEGE OF COMPUTER SCIENCES & ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

COE 402 – Computer Systems Performance Evaluation
Assignment 1 – Due Sat July 16, 2005

Problem 1:

Suppose that a queueing system is empty at time t = 0, and let the arrival times of the first five customers be 1, 3, 4, 7, 8, and let their respective service times be 3.5, 4, 2, 1, 1.5. **Tabulate** the arrival of i^{th} customer (A_i), service duration of i^{th} customer (τ_i), departure time of i^{th} customer (D_i), waiting time of i^{th} customer (W_i), total delay time of i^{th} customer (T_i) for i = 1,2, 3, 4, 5; Sketch $N(t)$ versus t; and check Little's formula by computing $\langle N \rangle_t$, $\langle \lambda \rangle_t$, and $\langle T \rangle_t$ for each of the following three service disciplines:

a) First-come-first-served (the tabulation for part a is available in the slides – N(t) for this case was plotted on the board!)

b) Last-come-first served

c) Shortest-job first

Hint: Little's formula: $\langle N \rangle_t = \langle \lambda \rangle_t \times \langle T \rangle_t$ – regardless of the service discipline

Problem 2:

Consider the same system specified in example detailed in class. We would like to make the errors in the data blocks random. If a data block is composed of n bits and a bit is likely to be in error with probability P_e, then the probability of k errors (assuming independent bit errors) in a block is given by

$$P_k = \binom{n}{k} P_e^k \left(1 - P_e\right)^{n-k} \qquad k = 0, 1, \cdots, n$$

Therefore, the probability the block has no errors is given by P_0. The probability the block has only one error is given by P_1, while the probability the block has more than one error is equal to $1 - P_0 - P_1$. Simulate the queueing system using 10 microsecond interarrival times but with random errors generated for a specific P_e and n. Use the code provided to determine the number of errors in a block and consequently the required service time.

1) Using P_e = 0.1 and n = 5, run the simulation for 1000 blocks and calculate the following quantites:

   a) Average number of blocks in the system
   b) Average waiting time for a block

Assume FCFS served disciple.

2) Plot average number of blocks in the system for n = 2, 5, and 10 and for all possible ranges of P_e.

Hint1: the Matlab code listed in the slides can be used for solving this problem since it employs a FCFS policy.

Hint2: To find the possible range for Pe, ρ =AverageArrivalRate X AverageServiceTime should always be less than 1. The average block service time is a function of both P_e and n.