Last name: _____

First name: _____

Student I.D. #: _____

Circle your section: ECE 440 or ECE 640

Department of Electrical and Computer Engineering
Clemson University

ECE 440/640 Performance Analysis of Local Computer Networks

2nd Midterm Exam Practice

Instructions:

1. Closed book examination.
2. Show your complete work.
3. 5 points penalty if you fail to enter name, ID#, or Section number.
4. **Units of all answers must be clearly indicated to obtain full credit.**
5. Stop writing immediately when end of exam is announced.
6. Failure to follow instructions may result in forfeiture of your exam and will be handled according to University academic misconduct procedures.

By signing below, I pledge my honor in completing the exam on my own and honestly abiding by all university testing regulations.

Signature: _____

Problem	*ECE 440 Points*	*ECE 640 Points*	*Score*
1	30	30	
2	30	30	
3	40	40	
4	---	30	
Total	100	130	

For all students:

1. (30 points) A ring LAN implements cyclic service with the following parameters:
   - 100 stations
   - Negligible propagation delay between stations
   - Per station latency B=2 bits
   - Link rate R=1 Mbps
   - Exhaustive service
   - MT (multiple-token), ST (single-token), or SF (single-frame) operations
   - Identical Poisson arrival to each station
   - Average packet size $\overline{X}$

   a. (10 points) If SF operation is chosen, packet sizes are exponentially distributed ($\overline{X}$ =1000 bits), each station has arrival rate 5 packets per second, find the *average transfer delay* for a packet in the network. Assume equally likely destinations from each source.
   b. (12 points) If packet sizes are exponentially distributed ($\overline{X}$ =1000 bits), find the *maximum arrival rates* supported by (i) MT, (ii) ST, and (iii) SF.
   c. (8 points) If packets have a fixed size, find the permissible range of *normalized ring latency* a' and *packet size* $\overline{X}$ such that MT and ST operations result in the same delay–throughput relationship.

2. (30 points) A ring LAN implements cyclic service with the following parameters:
   - 10 stations
   - minimum transfer delay 110μs for 100 bit packets
   - maximum cycle time 2100μs
   - Bounded interval, multiple-token
   - Identical Poisson arrival to each station
   - Equal walk time to adjacent stations.
   - Propagation speed is 5 μsec/km
   - Link rate R: 1Mbps

   a. (10 points) Find the *walk time* between two stations and the *per station interval bound*.
   b. (5 points) Find the *maximum per station arrival rate* in bits per second such that the network remains stable.
   c. (5 points) If each station incurs 6-bit station delay, find the *distance between two stations*.
   d. (10 points) If, instead of using tokens, the ring operates with a TDMA schedule in 100μs slots. No walk time between stations is needed. Each station has arrival rate 50 packets per second and fixed packet size 100 bits. Assume equally likely destinations for each source. Determine the *average transfer delay* of a packet.

3. (40 points) A random access network with a large number of stations employs a CSMA protocol with collision detection. Consider the following parameters:
    - channel sensing delay = entire bus propagation delay τ = 10 μsec
    - one packet transmission time P = 100 μsec
    - link capacity R = 100 Mbps

    a. (10 points) If S = G · Pr{successful transmission}, find the *maximum achievable throughput* S_{max}.
    b. (10 points) If G=0.8, find the *average number of retransmission attempts* for each successfully transmitted packet.
    c. (10 points) If G=0.8, find the *probability that three consecutive transmission attempts result in collisions.*
    d. (10 points) If G=0.8, find the *average interval with no stations transmitting*.

For ECE 640 students:

4. (30 points) Consider a FDDI token ring with heavily and lightly loaded stations. Multiple-token and bounded total cycle is adopted. Consider the following:
    - Link rate R = 1 Mbps
    - Exponentially distributed packet size ($\overline{X}$ = 100 bits)
    - Cycle bound α = 1 msec
    - Negligible token walk time between stations

    a. (10 points) If each lightly loaded station has a normalized throughput of 0.1, find the station's *arrival rate* in packets per second.
    b. (10 points) If the average cycle time T_C is 0.8 msec, find the average *per cycle normalized throughput* of a heavily loaded station.
    c. (10 points) If the average cycle time T_C is 0.8 msec, find the absolute *maximum per cycle throughput* for any station in this network.