SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2014
ENSC 427: COMMUNICATION NETWORKS
ENSC 894 SPECIAL TOPICS II: COMMUNICATION NETWORKS

Midterm No. 2
Wednesday, March 19, 2014

Duration: 50 minutes. Attempt all problems. Questions are not equally weighted.

Closed book and closed notes. Simple calculators (with no graphing/programming functions) are permitted. PDAs, laptops, and wireless phones are not permitted.

Please provide brief and concise answers and include diagrams, graphs, and tables, as needed. Expand all acronyms.

Please write legibly. Illegible text will not be graded. Please use a pen (no pencils, please).

1. **Circuit Switching Networks (30 points)**:
Consider a Clos switch with N inputs and N outputs, where the N inputs are grouped into N/n groups of n input lines.

   (a) Draw the general architecture of the three-stage Clos non-blocking switching fabric.

   (b) Find the smallest number of intermediate stages k for a non-blocking switch?

   (c) Justify your answer.

   (d) Calculate the number of cross points required in a three-stage switch. Include all switch components.

   (e) Find an approximate value of n that minimizes the number of cross points for a non-blocking switch architecture. Calculate this minimum number of cross points.

2. **Peer-to-Peer Protocols and Data Link Layer (25 points)**:

   (a) Describe the selective repeat ARQ protocol using the flowing sequence of events diagram. Include the case when one frame is lost. Clearly identify frame numbers and ACK/NACK numbers.

   (b) What is the maximum allowable size for the send window W_s and the receive window W_r for a given sequence numbering $N = 2^m$?

   (c) Provide a example that justifies your answer.

   (d) Calculate the efficiency of selective repeat ARQ if the probability of frame loss is P_f.

   (e) What is the effective information transmission rate in the absence of errors?

3. **Medium Access Control Protocols and Local Area Networks (25 points)**:

   (a) Graphically describe the basic operation of the ALOHA random access scheme.

   (b) Let G be the total load in frames/X seconds. Calculate the throughput S.

   (c) Graphically describe the basic operation of the Slotted ALOHA random access scheme.

   (d) Let G be the total arrival rate. Calculate the throughput S.

   (e) Graphically show throughput S versus load G for ALOHA and Slotted ALOHA and indicate the maximum values.

4. **OPNET Tutorial (M/M/1 Queue) (20 points)**:

   (a) Describe the M/M/1 queue, show the system diagram, and describe its components.

   (b) Describe the main model parameters.

   (c) Describe the process model attributes for the processor module.

   (d) List the statistics that you collected in the OPNET M/M/1 Queue tutorial. Show graphs illustrating typical simulation results.