

**SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE**

**Spring 2013
ENSC 427: COMMUNICATION NETWORKS**

**Final Examination
Saturday, April 20, 2013**

Duration: 180 minutes. Attempt all problems. Questions may not be equally weighted, Please provide detailed answers and include diagrams and tables, as needed. Expand all acronyms. Closed book and closed notes. Simple calculators (with no graphing/programming functions) are permitted. PDAs, laptops, and wireless phones are not permitted. Use a ball-point pen for writing the exam (no pencils, please).

1. Digital Transmission Fundamentals (20 points):

- (a) Give the formula for the Shannon channel capacity. Explain all variables.
- (b) Define SNR and give its units.
- (c) Explain the Nyquist signaling rate. Provide a simple example.
- (d) What is the bandwidth of a channel? Provide a simple example.
- (e) Briefly describe sampling and quantization of analog signals.

2. Circuit-Switching Networks (20 points):

- (a) Describe a general architecture of a non-blocking switch.
- (b) Describe head-of-line blocking and show a relevant switch architecture.
- (c) Consider a Clos non-blocking circuit switch with k intermediate switches and n inputs. Derive the non-blocking condition.
- (d) Describe the architecture of the Sunshine switch.

3. Packet-Switching Networks (30 points):

- (a) Show the network layers and protocol stacks and identify the end-to-end and the node-to-node layer operations.
- (b) Describe routing. Identify the layer responsible for its implementation.
- (c) What are routing tables and where are they stored?
- (d) Name and describe two main shortest-path routing algorithms. Provide examples using a simple network of your choice.

4. **TCP/IP (30 points):**

- (a) Describe the TCP connection establishment and termination.
- (b) List main phases of the TCP congestion control algorithm. Indicate each phase on a plot of *TCP window size* vs. *time*.
- (c) Name and describe the TCP feedback mechanism in case of packet loss. How is the packet loss detected by TCP? How does TCP react to each type of packet loss?
- (d) What is *round-trip time* and how is it estimated?
- (e) What is *timeout* and how is its value set in TCP?