

SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2016
ENSC 427: COMMUNICATION NETWORKS

Final Examination
Friday, April 22, 2016

Duration: 180 minutes. Attempt all problems. Questions are not equally weighted. Closed book and closed notes.

Please provide detailed answers and include diagrams, graphs, and tables, as needed. Expand all acronyms. Simple calculators (with no graphing/programming functions) are permitted. PDAs, laptops, and wireless phones are not permitted. Please write legibly. Illegible text will not be graded. Please use a pen (no pencils, please).

1. Circuit Switching Networks (15 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) Calculate the number of cross points required in a three-stage switch. Include all switch components.

2. Peer-to-Peer Protocols and Data Link Layer (35 points)

- (a) Use *the flowing sequence of events diagrams* and clearly identify both the frame and ACK numbers to describe the following ARQ protocols:
 - i. Stop-and-Wait
 - ii. Go-Back-N
 - iii. Selective Repeat
- (b) What is the maximum window size in each case?

3. Packet-Switching Networks (30 points):

Consider the packet network shown in Figure 1.

- (a) Use the Bellman-Ford algorithm to find the shortest path from node 1 to node 8. Show each step of the algorithm using an appropriate table. Draw the shortest path tree from all the other nodes to node 8.
- (b) Use the Dijkstra algorithm to find the shortest path tree from node 1 to node 8. Show each step of the algorithm using an appropriate table. Draw the shortest path tree from node 1 to all the other nodes.

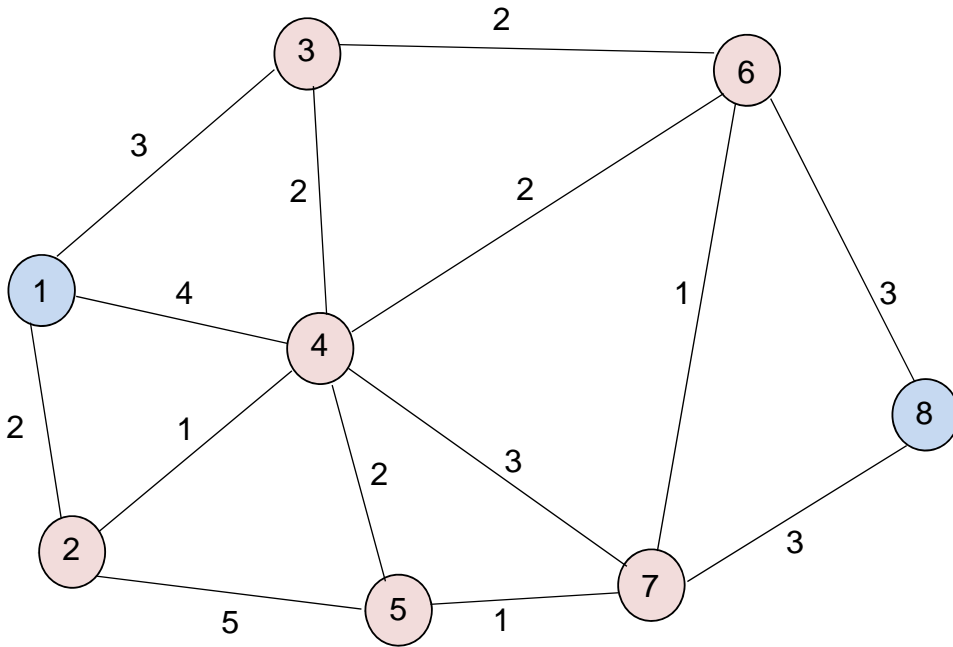


Figure 1: Packet network with eight nodes.

4. **TCP/IP (20 points):**

- (a) Describe the TCP connection establishment.
- (b) Describe the TCP connection termination.
- (c) Illustrate the four phases of the TCP congestion control using a plot of *TCP window size* vs. *time*.
- (d) Describe two mechanisms employed by TCP to detect packet loss and TCP reaction in each case.