SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2023
ENSC 427: COMMUNICATION NETWORKS
ENSC 894: SPECIAL TOPICS II COMMUNICATION NETWORKS

Midterm No. 2
Tuesday, April 4, 2023

Duration: 110 minutes. Attempt all problems. Questions are not equally weighted. Please provide detailed answers and include diagrams, graphs, 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. Please write legibly. Illegible text will not be graded. Please use a pen (no pencils, please).

1. **Chapter 4: The Network Layer: Data Plane (30 points)**:
   A network layers service model defines the characteristics of end-to-end transport of packets between sending and receiving hosts.

   (a) What is the service model of the Internets network layer? (5 points)

   (b) What guarantees are made by the Internets service model regarding the host-to-host delivery of datagrams? (5 points)

   (c) What is the role of the forwarding table within a router? (5 points)

   (d) Consider FIFO, Priority, Round Robin (RR), and Weighted Fair Queueing (WFQ) packet scheduling disciplines, Which of these queueing disciplines ensure that all packets depart in the order in which they arrived? (5 points)

   (e) What field in the IP header can be used to ensure that a packet is forwarded through no more than N routers? (4 points)

   (f) Suppose two packets arrive to two different input ports of a router at exactly the same time. Also suppose there are no other packets anywhere in the router. Suppose the two packets are to be forwarded to two different output ports. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses:

      i. a shared bus? (2 points)

      ii. switching via memory? (2 points)

      iii. a crossbar? (2 points)

2. **Chapter 5: The Network Layer: Control Plane (35 points)**:
Consider the two families of routing algorithms.

   (a) Write the pseudo code for each algorithm. (10 points)

   (b) Consider the network shown in Figure 1. With the indicated link costs, use Dijkstra's algorithm to compute the shortest path from A to all network nodes.

      i. Show how the algorithm works by computing an appropriate table. (10 points)

      ii. Draw the shortest path tree found by the algorithm. (5 points)

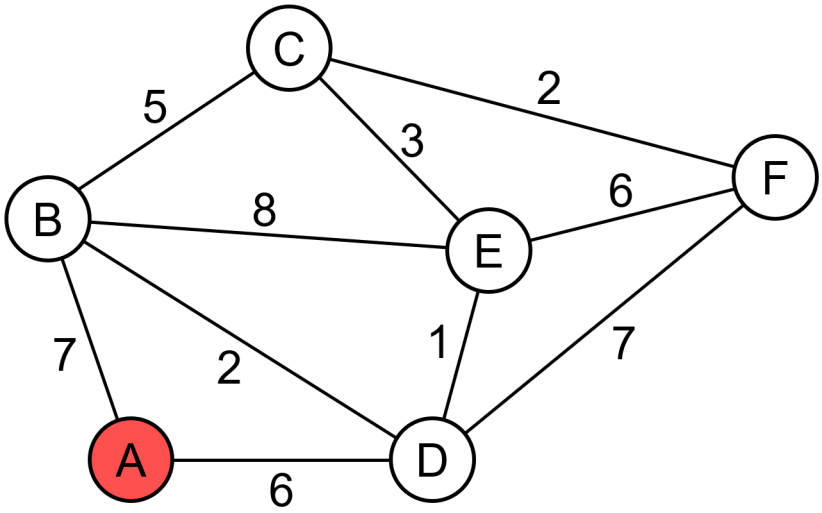

Figure 1: Apply Dijkstra's algorithm to find the shortest path from node A.

   (c) Consider the network shown in Figure 2. Assume that each node initially knows the costs to each of its neighbors. Use Bellman-Ford algorithm and show the routing table entries at node A. (10 points)

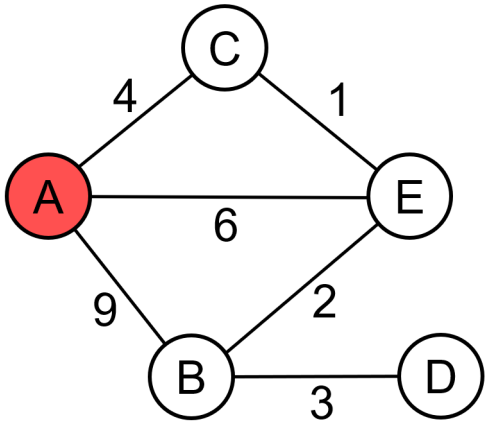

Figure 2: Apply Bellman-Ford algorithm to show the routing table entries at node A.

3. **Chapter 6: The Link Layer and LANs (25 points)**:
Consider the random access Media Access Control (MAC) protocols.

   (a) In CSMA/CD, what is the probability that a node chooses K = 5 after the sixth collision? (5 points)

   (b) The result K = 5 corresponds to a delay of how many seconds on a 10 Mbps Ethernet? (5 points)

   (c) Derive the efficiency of slotted ALOHA. Recall that when there are N active nodes, the efficiency of slotted ALOHA is $Np(1-p)^{N-1}$.

      i. Find the value of p that maximizes this expression. (10 points)

      ii. Using the value of p found in (i), find the efficiency of slotted ALOHA by letting N approach infinity. (5 points)

4. **Case Study: Implementation of BGP in a network simulator (10 points):**
Consider the cases study dealing with implementation of the Border Gatewey Protocol (BGP) in ns-2.

   (a) What are BGP peers and what is a BGP session? (2 points)

   (b) List four types of BGP messages. (2 points)

   (c) Describe the goal of the study and the simulation scenario. (3 points)

   (d) Show network topology and all types of BGP nodes used in the simulated network. (3 points)