Introduction to Computer Networks **Name:** _____
Fall 2020
Homework 2 (Due: 12/22/2020) **ID:** _____

This homework contains 7 questions. The deadline is on Dec. 22 (Tue) at 23:59. Please submit your answers to new E3.

1. (10 points) **Network layer:**
   (a) (4 points) Explain what is the difference between the control plane and data plane.

   (b) (2 points) Is IP (Internet Protocol) a best effort protocol or a QoS guaranteed protocol?

   (c) (4 points) Explain what is the major difference between traditional routers and programmable switches.

2. (15 points) **Router:**
   (a) (4 points) List the four components of a router.

   (b) (3 points) When will the input queue (or the output queue) of a router overflow, leading to packet losses?

(c) (4 points) Why we prefer *prefix matching*, instead of ID matching, during packet forwarding?

(d) (4 points) Explain when will a flow match multiple rules in a forwarding table. Explain WHY we adopt *longest prefix matching* to resolve this issue.

3. (10 points) **Queueing.** Consider a router that help forward packets classified into two classes. Say that ten packets arrive the router with the following class and arrival time:

sequence	1	2	3	4	5	6	7	8	9	10
class	2	1	1	2	1	2	1	1	2	1
time (second)	1.5	2.0	2.2	2.5	4.0	4.5	5.2	7.8	8.4	8.6

Assume that the transmission time of each packet is *one second*.

(a) (5 points) Assume that class 1 has a high priority, while class 2 has a low priority. When will each packet be sent if the router forwards packets using priority queueing? (Note that there is no preemptive.)

(b) (5 points) When will each packet be sent if the router forwards packets using round robin queueing?

4. (15 points) **Subnet.**
   (a) (5 points) What is the maximum number of hosts in the subnet 140.113.100.0/20?

   (b) (5 points) What is the subnet mask of subnet 140.113.100.0/20 in decimal?

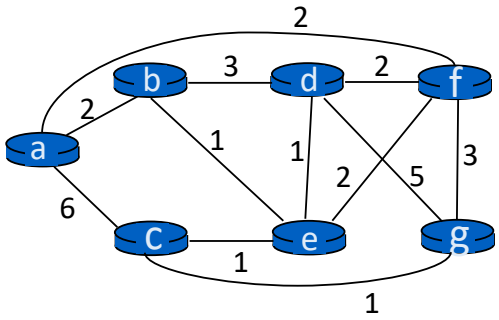
   (c) (5 points) If this subnet only includes 1,000 host, what is a more efficient subnet mask? (hint: minimize the number of non-occupied IP addresses)

5. (15 points) **DHCP.**
   (a) (5 points) Explain why DHCP uses link-layer broadcasting to send requests.

   (b) (5 points) Why does a DHCP request require four messages (including DHCP request and ACK), instead of just two messages?

   (c) (5 points) If this subnet only includes 1,000 host, what is a more efficient subnet mask? (hint: minimize the number of non-occupied IP addresses)

6. (15 points) **Link-state routing.** Consider the following network topology with 6 nodes. Let the number associated with each link be the cost of the link. Try to find the shortest path from node a to the remaining nodes using the link-state algorithm.

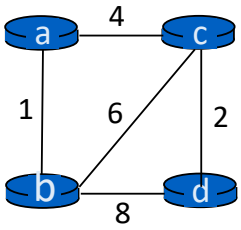


(a) (5 points) Write down the step-by-step procedure of the link-state algorithm as building the distance/predecessor table from node a to all the remaining nodes.

(b) (5 points) What is the routing path from a to g?

(c) (5 points) What is the forwarding table at node b?

7. (20 points) **Distance-vector routing.** Consider the following network topology with 4 nodes. Let the number associated with each link be the cost of the link. Try to find the shortest path from each node to the remaining nodes using the distance-vector algorithm.



(a) (4 points) What is the initial distance vector of each of the four nodes?

(b) (4 points) Assume that all the nodes broadcast their distance vectors $\mathbf{D}_i$ at the same time. What will be the distance vector of each of the four nodes after receiving the initial distance vector from the neighbors (i.e., the distance vector of all nodes after the first information exchange)?

(c) (8 points) Assume that all the nodes broadcast their updated distance vectors at the same time. Write down the detailed information exchange and distance vector update procedure until convergence.

(d) (2 points) How many iterations are required to achieve convergence?

(e) (2 points) What is the shortest path from node c to node d?