Introduction to Computer Networks **Name:** _____
Fall 2021
Homework 2 (Due: 12/26/2021) **ID:** _____

This homework contains 8 questions. The deadline is on Dec. 26 (Sun) at 23:59. Please submit your answers to new E3.

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1. (10 points) **Router:**
   (a) (4 points) List the four components of a router.

   (b) (2 points) When will the input queue (or the output queue) of a router overflow, leading to packet losses?

   (c) (2 points) Why we prefer *prefix matching*, instead of ID matching, during packet forwarding?

   (d) (2 points) Explain when will a flow match multiple rules in a forwarding table. Explain WHY we adopt *longest prefix matching* to resolve this issue.

2. (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	1	1	2	2	1	2	2	1	2	1
time (second)	0.5	1.0	1.2	2.5	3.0	5.0	5.5	6.3	8.2	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?

3. (15 points) **Subnet.**

   (a) (4 points) What is the maximum number of hosts in the subnet 140.113.10.0/22?

   (b) (3 points) Following the above question, what is the IP address reserved for broadcasting?

   (c) (4 points) What is the subnet mask of subnet 140.113.10.0/22 in decimal?

   (d) (4 points) If this subnet only includes 2,000 host, what is a more efficient subnet mask? (hint: minimize the number of non-occupied IP addresses)

4. (10 points) **DHCP.**

   (a) (3 points) Explain why DHCP uses link-layer broadcasting to send requests.

   (b) (2 points) Why does a DHCP request require two requests, instead of just one request?

(c) (2 points) Explain what is a lease of a dynamic address allocated by DHCP?

(d) (3 points) Explain why DHCP can address the issue of insufficient IP addresses.

5. (10 points) **SDN:**

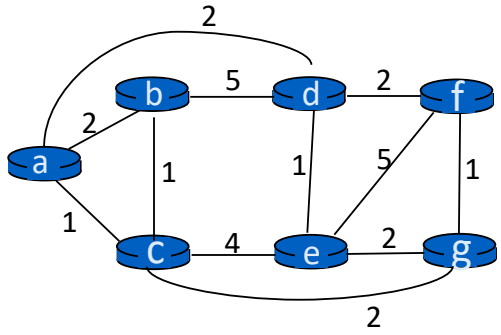
(a) (2 points) Explain what is the major difference between traditional routers and programmable switches.

(b) (4 points) List the fields that can be matched in the OpenFlow protocol.

(c) (2 points) List the actions that can be performed in the OpenFlow protocol.

(d) (2 points) Define what is the 5-tuple of a flow.

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.

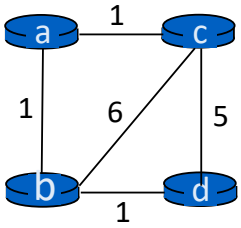


(a) (8 points) Write down the step-by-step procedure of the link-state algorithm as building the distance/predecessor table from node a to all the remaining nodes.

(b) (3 points) What is the routing path from a to g?

(c) (4 points) What is the forwarding table at node c?

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? (Note that the last iteration, which is duplicated with the previous iteration, should also be counted.

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

8. (10 points) **MAC.** Medium access control protocols.
   (a) (2 points) Give two key shortages of channel partitioning.

   (b) (3 points) Explain what is *collision avoidance* in a random access protocol. Why could random access be better than channel partitioning?

   (c) (5 points) Explain the difference between *collision detection* and *collision avoidance*. Why does 802.3 exploit collision detection, but 802.11 exploit collision avoidance?