Introduction to Computer Networks **Name:** _____
Fall 2019
Homework 2 (01/03/2020)

This homework contains 7 questions. The deadline is on Jan. 3 (Fri.) 23:59.
Total of points is 100. Please submit your answers to *gradescope*.

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1. (10 points) **Control and data plane:**
   (a) (5 points) Briefly explain what is the control plane and the data plane in a router. Describe what are their major tasks.

   (b) (5 points) Briefly explain what is the difference between the per-router control plane and the centralized control plane.

2. (10 points) **Network address translation:**
   (a) (5 points) Explain what is the difference between a private network and a public network.

   (b) (5 points) Explain what is the main task of the network address translation (NAT) protocol.

3. (15 points) **Prefix matching.** Consider the following routing table at a router.

prefix	output port
`11010011 00111001 101***** ********`	1
`11010011 00111001 101101** ********`	2
`11010011 00111001 011***** ********`	3
otherwise	4

   (a) (5 points) What is the output port is the destination address is `11010011 00111001 10110101 11100011`?

   (b) (5 points) What is the output port is the destination address is `11010011 00111000 01100101 11100011`?

   (c) (5 points) What is the output port is the destination address is `11010011 00111001 01100101 01110011`?

4. (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	2	2	1	1	2	1	2	1	1
time (second)	1.6	2.0	2.5	2.8	5.0	5.5	5.8	7.5	7.7	9.5

   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.)

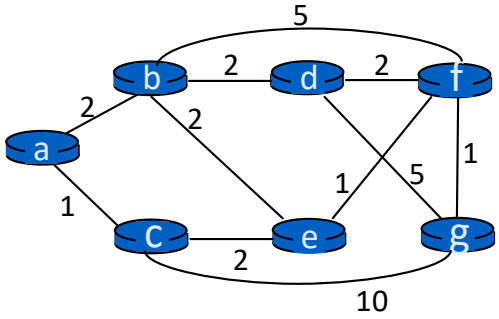
(b) (5 points) When will each packet be sent if the router forwards packets using round robin queueing?

5. (10 points) **Subnet.**

(a) (5 points) What is the maximum number of hosts in the subnet 140.113.203.0/22?

(b) (5 points) What is the subnet mask of subnet 140.113.203.0/22 in decimal?

6. (20 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.

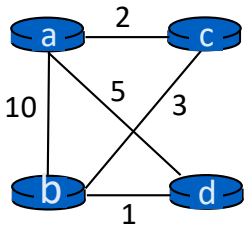


(a) (10 points) Write down the step-by-step procedure of the link-state algorithm as building the distance/predecessor table from node a to all the remaining nodes.

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

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

7. (25 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) (5 points) What is the initial distance vector of each of the four nodes?

(b) (5 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) (5 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) (5 points) How many iterations are required to achieve convergence?

(e) (5 points) What is the shortest path from node c to node d?