CS 421: Computer Networks **FALL 2004**

MIDTERM II
December 20, 2004
120 minutes

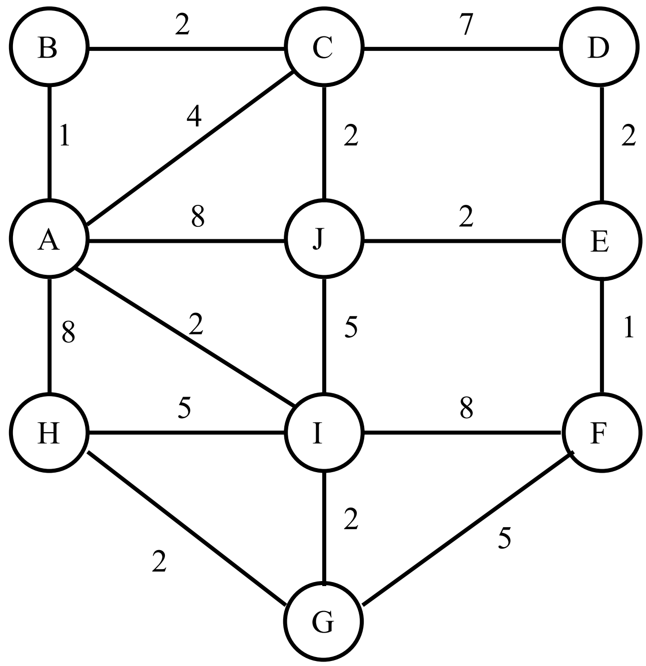
Name: ______________________________

Student No: ____________________________

Show all your work very clearly. Partial credits will only be given if you carefully state your answer with a reasonable justification.

1)

a) (13 pts) Execute the Dijkstra algorithm at node A for the network shown below by filling in the following table. In the table, you need to give both the distance *D(v)* and previous node *p(v)*.



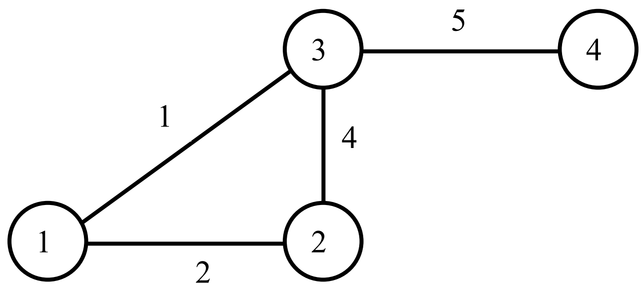
iter.	*N*	*D(B), p(B)*	*D(C), p(C)*	*D(D), p(D)*	*D(E), p(E)*	*D(F), p(F)*	*D(G), p(G)*	*D(H), p(H)*	*D(I), p(I)*	*D(J), p(J)*

b) (13 pts) The network below uses the distance-vector routing algorithm **with poisoned reverse**. Assume the following:

- Links have the same cost in both directions.
- Nodes exchange their routing info once every second, in perfect synchrony and with negligible transmission delays. Specifically, at every t = i, i = 0, 1, 2, 3,..., each node sends and receives routing info instantaneously, and updates its routing table; the update is completed by time t=i+0.1.
- At time t = 0, the link costs are as shown below and the routing tables have been stabilized. At time t = 0.5, the cost of the link (3,4) becomes 20. There are no further changes in the link costs.
- Route advertisements are **only exchanged periodically**, i.e., there are no immediate route advertisements after a link cost change. Hence the first route advertisement after the link cost

change at t = 0.5 sec occurs at t = 1.0 sec. *Note:* However, whenever a link cost change occurs, the two nodes at the endpoints of this link immediately make corresponding changes in their distance tables.

Give the evolution of the distance tables with respect to destination 4. Specifically, give the distance table entries for destination 4 at nodes 1-3, for t = 0.1, 0.5, 1.1, 2.1, ..., **until** all distance vectors stabilize. Present your final answer in the table given below where $D^i(j)$ is the distance vector denoting the distance from i to j .



Time, t	$D^1(4)$ via		$D^2(4)$ via		$D^3(4)$ via		
	2	3	1	3	1	2	4
0.1							
0.5							
1.1							
2.1							
3.1							
4.1							
5.1							
6.1							
7.1							
8.1							
9.1							
10.1							
11.1							

2)

a) (10 pts) Suppose host A transmits a 1500 byte IP packet over a 2-hop path to host B. The MTU of the first link (A to router) is 700 bytes, and the MTU of the second link (router to B) is 500 bytes. Assuming that IP header does not contain any options, indicate the length (in bytes), more flag, and offset field values **(specify the offset values in units of 8 bytes)** of the fragment(s) transmitted over each link in the tables below.

First link

Fragment	Length	Offset	Flag
1			
2			
3			
4			
5			
6			

Second link

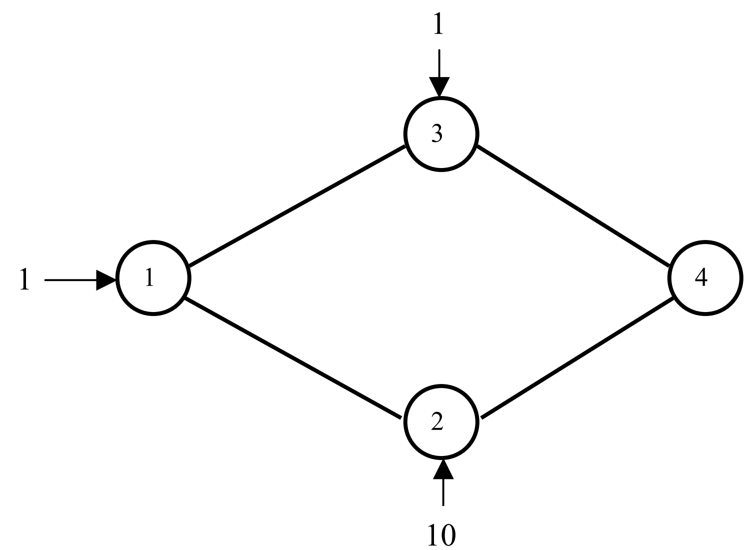
Fragment	Length	Offset	Flag
1			
2			
3			
4			
5			
6			

b) (10 pts) The Faculty of Engineering at the Lunar Institute of Technology has four departments: Computer Engineering (CE), Electrical Engineering (EE), Aeronautics Engineering (AE) and Mining Engineering (ME). The number of hosts at each department is listed in the following table. The faculty owns the 101.101.176.0/22 CIDR address block and wants to form four subnets, one for each department. Give a possible arrangement of network address blocks assigned to the departments in the table below. Use notation similar to 101.101.176.0/22 to denote the address blocks.

Department	# of hosts	Address Block (X.Y.Z.W/X)
CE	318	
EE	235	
AE	108	
ME	69	

3)

a) (13 pts) Consider the 4-node network shown below. Nodes 1, 2 and 3 are source nodes, and node 4 is the only destination node. The incoming traffic rates into nodes 1, 2 and 3 are 1, 10 and 1 packets/unit time, respectively. For any link (*i,j*) the link cost from *i* to *j* is given by $\alpha + y_{ij}$, where y_{ij} is the total traffic routed from *i* to *j* (in packets/unit time), and α is a constant. On the other hand, the link delay from *j* to *i* is given by $\alpha + y_{ji}$, where y_{ji} is the total traffic routed from *j* to *i*. Assume that nodes are running an iterative distributed shortest path routing algorithm, and they are routing all their traffic along the shortest path computed at that iteration. We assume that nodes are synchronized, i.e., they perform the iterations in a perfectly synchronous manner. The desired routing pattern is such that nodes 2 and 3 route all their traffic along their min-hop paths, i.e., 2-4 and 3-4, respectively, and node 1 routes all its traffic along the path 1-3-4. Assume that initially, i.e., before iteration 1, the following routes are used: node 1 uses 1-2-4, node 2 uses 2-1-3-4, and node 3 uses 3-4. Find the **minimum value** of α such that the iterative distributed routing algorithm converges to the desired routing pattern.



b) (4 pts) List two network application programs that use ICMP.

c) (9 pts) Suppose that the input and output line speeds of a router are identical and there are 10 input and 10 output ports. For each of the following three cases, state whether input and/or output buffering is necessary (possible answers that you can give for each case are **input, output, neither input or output, and both input and output buffering is/are necessary**). Briefly state your reasoning for each answer.

i) The switching fabric speed is equal to the line speed.
ii) The switching fabric speed is equal to 6 times the line speed.
iii) The switching fabric speed is equal to 12 times the line speed.

4)

a) (8 pts) Suppose there are 10 nodes engaged in a collision in a Slotted Aloha network, i.e., all 10 nodes transmitted their frames in the same time slot and experienced a collision. Find the optimum value of the retransmission probability p such that the probability of a successful transmission is maximized. **You need to justify your answer mathematically.**

b) (6 pts) Explain why collisions may still occur in a random access MAC protocol although all nodes perform carrier sensing. **(Use at most <u>three</u> sentences.)**

c) (6 pts) What are the error detection capabilities of the following codes, i.e., state how many bit errors that they are capable of detecting?

i) Single parity codes
ii) Two-dimensional parity codes
iii) Checksum

d) (8 pts) Given the following 8-bit data 10010001 and the generator sequence 10111, how many CRC bits are appended at the end of the data? Compute the CRC bits and give the transmitted bit sequence.