## CS 3873
Computer Networks
Midterm 2 Solution

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<td>Question 5</td>
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NAME:_____________________________________

**Instructions**
1. Do all of the problems
2. You have 75 minutes for the exam
3. Show all your work
4. Do not separate midterm papers
1. (20 pts, 2 pts each) Answer the following True/False Questions. Explain your answer briefly.

(a) Every autonomous systems uses the same intra-AS routing algorithm.
   False, autonomous systems can use any intra-AS they choose.

(b) Routers can have multiple IP addresses.
   True, for each interface they have an IP address.

(c) 228.8.5.4 is a multicast Address.
   True, it starts with 110.

(d) ATM provides constant bit rate service.
   True, ATM constant bit rate service provides guarantees for delay, jitter and loss.

(e) Forwarding table of a router in a VC network includes incoming VC# and outgoing VC#.
   True, VC#’s are used to forward to proper outgoing interface.

(f) VC# does not change on a path from source to destination in a VC network.
   False, VC# may change on each edge on the path.

(g) Bus can not be used as a switching fabric in a router.
   False, memory, bus or an interconnection network can be used as switching fabric.

(h) IP datagrams can be of any length up to 4GB.
   False, maximum IP datagram size is $2^{16}$ bytes.

(i) A NAT router can support 1 million nodes behind it.
   False, since port number is used to identify the connection. It can support at most $2^{16}$ nodes behind it.

(j) Forwarding tables at routers are constructed using only intra-AS routing algorithm.
   False, both intra-AS and inter-AS routing algorithms are used.
2. (20 pts, 4 pts each) Explain the following concepts briefly.

(a) What are the main components of a router?
   
i. Input ports
   ii. Output ports
   iii. Switching fabric
   iv. Routing processor

(b) Explain the difference between intra-AS routing and inter-AS routing and given an example protocol for each.
   
   Routers are divided into Autonomous systems. Routers within the same AS run the same routing algorithm. Routing within an autonomous system is called intra-AS routing and routing among various ASs is called inter-AS routing. RIP and OSPF are intra-AS routing protocols and BGP is an inter-AS routing protocol.

(c) How does use of IP addresses in multicast differ from use of IP addresses in unicast.
   
   Each multicast group is assigned a multicast IP address. Destination IP address of messages sent to this group is the multicast IP address and all the members of the multicast group receive the message sent to the group. In unicast only the node with the specified destination address receives the message.

(d) Briefly explain how two-dimensional parity works. Each row and each column has an associated parity bit. It can correct single bit errors by identifying the location using the row with mismatched parity and the column with mismatched parity.

(e) CEO of a company is building a telephony network. He can either choose equipment that uses virtual circuits or equipment that uses datagram networks. He is mainly interested in quality of the calls. Which one should he/she pick? why?
   
   Since quality of calls is the main issue he/she should pick virtual circuit based equipment. In VC networks resources are reserved, so all the voice packets are guaranteed to be received by the receiver without any problems. In datagram networks packets can be lost degrading the quality of the calls.
3. (20 pts) Consider the following network. With the indicated costs, use Dijkstra’s shortest-path algorithm to compute the shortest path from u to all network nodes.

Fill in the following table to show execution of the algorithm

<table>
<thead>
<tr>
<th>Step</th>
<th>N'</th>
<th>D(s),p(s)</th>
<th>D(t),p(t)</th>
<th>D(v),p(v)</th>
<th>D(w),p(w)</th>
<th>D(x),p(x)</th>
<th>D(y),p(y)</th>
<th>D(z),p(z)</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>u</td>
<td>4,u</td>
<td>2,u</td>
<td>1,u</td>
<td>3,u</td>
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<td>∞</td>
<td>∞</td>
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<td>2,u</td>
<td>2,v</td>
<td>4,v</td>
<td>2,v</td>
<td>∞</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>uvt</td>
<td>3,t</td>
<td></td>
<td>2,v</td>
<td>4,v</td>
<td>2,v</td>
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</tr>
<tr>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td>4,t</td>
</tr>
</tbody>
</table>
4. (5+5+5+5 pts) Consider the slotted ALOHA protocol where each node transmits with probability $p$ for fresh frames as well as frames that has suffered a collision. Measurements of a slotted ALOHA channel with 3 users, each with lots of data to send, shows that 12.5% of the slots are idle. Answer the following based on this information.

**Answer:** For a system with 3 users, success probability = $3p(1-p)^2$, idle probability = $(1-p)^3$ and collision probability = $p^3 + 3p^2(1-p)$.

(a) What is the parameter $p$ used by the system?
Since $(1-p)^3 = \frac{1}{8}$, $1-p = \frac{1}{2}$ and $p = \frac{1}{2}$.

(b) What is the percentage of collision slots?
Using $p = 1/2$, collision probability = $(\frac{1}{2})^3 + 3(\frac{1}{2})^2(1 - \frac{1}{2}) = \frac{1}{2}$. First term above is probability that 3 nodes collide and second term is probability that any two nodes collide. Percentage of collision slots is 50%.

(c) What is the efficiency of the system?
Efficiency is success probability. So, efficiency = $3\frac{1}{2}(1 - \frac{1}{2})^2$. After simplification, you get $\frac{3}{8}$.

(d) Is the parameter $p$ used the best parameter (maximizes efficiency)?
To find optimal parameter, take the derivative of $3p(1-p)^2$ and set it to 0. You get $p = \frac{1}{3}$. 
5. (20 pts) Consider the following network with the given IP addresses. Fill out the routing table of router A. Try to minimize the number of entries in the routing table.

Routing Table of router A

<table>
<thead>
<tr>
<th>Destination Network</th>
<th>Next Router</th>
<th>Number of Hops</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>180.12.16.0/24</td>
<td>-</td>
<td>1</td>
<td>180.12.16.1</td>
</tr>
<tr>
<td>129.115.0.0/20</td>
<td>B</td>
<td>2</td>
<td>180.12.12.1</td>
</tr>
<tr>
<td>190.15.23.0/24</td>
<td>B</td>
<td>2</td>
<td>180.12.12.1</td>
</tr>
<tr>
<td>default</td>
<td>C</td>
<td>2</td>
<td>180.12.13.1</td>
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