Final Exam Review

CMPSC 381
Data Communications and Networks
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Final Exam Review

The final exam is scheduled for Thursday, 5 May, from 9 a.m. to noon. It will cover all of the material in the course, but with an emphasis on the topics listed below. Material covered since the second exam may be more prevalent on the final exam than earlier material.

You may bring one 8 1/2 by 11 sheet of paper with anything written on it (both sides) that you wish. Use of books, notes, computers, calculators or other resources is not allowed during the exam.

If an answer requires numerical calculation it can be left in partially-evaluated form as “$A \times 10^P$” where $A$ may be a simple arithmetic expression and $P$ is a single integer. You may need to perform “trivial” arithmetic to obtain this form—for instance, you should not write “$1/2 \times 10^8$”, but “$1/2 \times 10^{-8}$” or, better yet, “$.5 \times 10^{-8}$”.

Topics include:

- General concepts of programming—delay, loss, and throughput; basic notions of packet-switching, layered architectures, etc.

- Basic socket programming in Python (on a “recognition” basis—you will not be asked to write code from scratch)

- Other software tools: Wireshark, dig—be able to interpret output

- Application layer—particular emphasis on HTTP, DNS, BitTorrent

- Transport layer—TCP and UDP general principles, multiplexing, demultiplexing, checksums, TCP flow control, TCP congestion control. You don’t need to memorize segment structures, but you should know what various fields are used for, e.g., sequence and acknowledgement number fields, flags, etc.

- Network layer—segmentation, subnets and CIDR, addressing, DHCP and NAT (purposes and basic behavior), routing table basics (e.g., longest-prefix property), Dijkstra’s algorithm, distance vector algorithm, broadcast and multicast, ICMP. You don’t need to memorize the datagram structure, but know the uses of the important fields, e.g., fragmentation offset, time-to-live, etc.

- Link Layer—cyclic redundancy codes, categories of multiple-access protocols, time- and frequency-division multiplexing, CSMA/CD, MAC addresses, ARP

For material covered on the first two exams, see earlier review sheets. Here are examples of the kinds of questions that might be asked, with a definite bias towards material from the last few weeks of the course.
This is not intended to be a sample exam; the topics covered below are not intended to be an exhaustive review. In particular, knowing the answers to all the questions below will not guarantee a good grade on the exam!

1. Name the layers of the internet protocol stack, in order.

2. A 1000-bit packet is transmitted from host \( A \) to host \( B \) over a 1 km link. The transmission speed at \( A \) is 5 Mbps and the propagation speed is \( 2 \times 10^8 \) meters/sec. How long will it be until the packet is completely received by \( B \)? Show your work.

3. In the graph on the left of Figure 1, the nodes represent network routers and the edges represent costs. Complete the table on the right in Figure 1 as it would be filled in using Dijkstra's algorithm. The first row has been done for you.

4. An autonomous network owns a block of IP addresses designated as “123.123.123.0/24”.

   (a) What does the “24” mean?

   (b) If this block of IP addresses were further divided into two equal-sized subnets, how many addresses would be available in each subnet? Your choices are: \( 2^7 \), \( 2^8 \), or \( 2^9 \).

5. Given the data string “10101” and the CRC generator “110”, what two-bit remainder must be added on to the end of the data string to enable CRC checksum validation? Show your work. Here’s the setup (the last two bits—after the colon “;”— are initially 0; these must be replaced with the two-bit remainder that you compute):

   \[ \begin{array}{c}
   \text{110) 10101:00} \\
   \hline
   \end{array} \]

6. Three routers, \( A \), \( B \), and \( C \), are connected by links with costs as shown in Figure 2.

   Fill in the initial distance vector tables for each one (“initial” meaning that each router knows only about the costs of the links immediately adjacent to it).
7. A routing table looks like the following:

<table>
<thead>
<tr>
<th>Prefix Match</th>
<th>Link Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>11001000 00010111 00011000</td>
<td>0</td>
</tr>
<tr>
<td>11001000 00010111 00011000</td>
<td>1</td>
</tr>
<tr>
<td>11001000 00010111 00011111</td>
<td>2</td>
</tr>
<tr>
<td>otherwise</td>
<td>3</td>
</tr>
</tbody>
</table>

For each of the following destinations, which link interface would be selected?

(a) 11001000 00010111 00011000 11001100
(b) 11001000 00000011 11011000 11001100
(c) 11001000 00010111 11011011 00000100

8. In Figure 2, a client at IP address 138.76.29.7 wishes to send a request to a server at port 12345 on a host whose local IP address (in a local area network) is 10.0.0.1; a router lies between the client and the server as shown.

   (a) What must the router be capable of doing so that the client’s request can be processed?
   (b) Will the port number in the client’s request always be “12345”? Why or why not?

9. What is DHCP and what is it used for?

10. True/False:

   (a) The ICMP protocol lies somewhere on the boundary between the network layer and the link layer.
(b) Link layer frames use a 6-byte source and destination address
(c) Two hosts connected to the internet at the same time can have identical IP addresses
(d) ARP is an organization for retired people
(e) NAT is used to assign an IP address to a new host that is trying to join a local area network

11. In the dig output shown in Figure 3, what is the authoritative IP address for the site cs.allegheny.edu?

12. Consider the following Python code segment:

```python
sock = socket(AF_INET,SOCK_DGRAM)
sock.sendto('hello',('localhost',12345))
```

(a) Does this use TCP or UDP? How do you know?
(b) Will the intended recipient of this message be guaranteed to receive it? Why or why not?

13. In which protocol layer does segmentation occur? Why is it needed?

14. What is “reverse path forwarding” and where is it used?
$ dig cs.allegheny.edu

; <<>> DiG 9.8.3-P1 <<>> cs.allegheny.edu
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 45369
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 4, ADDITIONAL: 4

;; QUESTION SECTION:
;cs.allegheny.edu. IN A

;; ANSWER SECTION:
;cs.allegheny.edu. 86400 IN CNAME aldenv29.allegheny.edu.
aldenv29.allegheny.edu. 86400 IN A 141.195.226.29

;; AUTHORITY SECTION:
allegheny.edu. 86400 IN NS campdns1.allegheny.edu.
allegheny.edu. 86400 IN NS resdns1.allegheny.edu.
allegheny.edu. 86400 IN NS asdns1.allegheny.edu.
allegheny.edu. 86400 IN NS amdns1.allegheny.edu.

;; ADDITIONAL SECTION:
amdns1.allegheny.edu. 86400 IN A 141.195.5.14
ashedns1.allegheny.edu. 86400 IN A 141.195.5.10
resdns1.allegheny.edu. 86400 IN A 141.195.130.2
campdns1.allegheny.edu. 86400 IN A 141.195.5.6

;; Query time: 4 msec
;; SERVER: 141.195.130.2#53(141.195.130.2)
;; WHEN: Fri Apr 29 08:45:24 2016
;; MSG SIZE  rcvd: 224

Figure 4: See problem 11