CPSC 441
COMPUTER COMMUNICATIONS

MIDTERM EXAM

Department of Computer Science
University of Calgary
Professor: Carey Williamson

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This is a CLOSED BOOK exam. Textbooks, notes, laptops, personal digital assistants, tablets, and cellular phones are NOT allowed. However, **calculators are permitted**.

It is a 50 minute exam, with a total of 50 marks. There are 12 questions, and 7 pages (including this cover page). Please read each question carefully, and write your answers legibly in the space provided. You may do the questions in any order you wish, but please USE YOUR TIME WISELY.

When you are finished, please hand in your exam paper and sign out. Good luck!

——————————- Fold here for privacy (optional) ——————————————-

Student Name: _____

Student ID: _____

Score: _____ / 50 = _____ %

Multiple Choice

Choose the best answer for each of the following 8 questions, for a total of 8 marks.

1 1. Negative ACKnowledgements (NAKs) are not needed in a Reliable Data Transfer (RDT) protocol if:

(a) sequence numbers are being used

(b) timeouts and retransmissions are being used

(c) checksums are being used

(d) wireless is being used

(e) tennis balls are being used

1 2. The primary difference between UDP and TCP is:

(a) TCP is a reliable byte stream protocol, while UDP is not

(b) TCP is connection-oriented, while UDP is connection-less

(c) TCP uses sequence numbers, while UDP does not

(d) TCP enforces flow control, while UDP has no flow control

(e) all of the above

1 3. The first version of TCP with "Slow Start" and "Congestion Avoidance" was:

(a) TCP Tahoe

(b) TCP Reno

(c) TCP NewReno

(d) TCP Vegas

(e) TCP SACK

1 4. In TCP NewReno, the acknowledgements serve as:

(a) an error control mechanism

(b) a flow control mechanism

(c) a congestion control mechanism

(d) all of the above

(e) none of the above

1 5. In a virtual circuit network, routing decisions are made:

(a) once per packet

(b) once per call

(c) once per hour

(d) once per day

(e) once per congestion episode (i.e., packet loss event)

1 6. In a datagram network, packet reordering is handled:

(a) at the ingress router

(b) at the egress router

(c) with clever buffer management in routers

(d) at the end systems

(e) none of the above

1 7. The Internet Protocol (IPv4) is an example of a:

(a) connection-less network layer protocol

(b) connection-oriented network layer protocol

(c) connection-less transport layer protocol

(d) connection-oriented transport layer protocol

(e) none of the above

1 8. Version 6 of the Internet Protocol (IPv6) improves upon IPv4 by:

(a) expanding the IP address space

(b) providing better support for mobility

(c) providing better support for Quality of Service

(d) all of the above

(e) none of the above

Networking Concepts and Definitions

12 9. For each of the following pairs of terms, **define** each term, and **clarify** the key difference(s) between the two terms. Be clear and concise.

(a) (4 marks) "flow control" and "congestion control"

(b) (4 marks) "go-back-N" and "selective repeat"

(c) (4 marks) "Transport Level Endpoint (TLE)" and "TCP Control Block (TCB)"

Reliable Data Transfer Protocols

10 10. In the RDT protocols discussed in class, we progressively relaxed several assumptions about our (initially perfect) network layer (NL), and added more and more functionality in the RDT protocol to make it work properly.

(a) (5 marks) Give ONE example of a type of NL error that broke one of our elementary protocols. What was the problem that arose? What was the solution to this type of error? How did it work? What state information was involved? Where did the state information reside, and why?

(b) (5 marks) Give ONE MORE example, distinct from the one above, of a type of NL error that broke one of our simple protocols. What was the problem that arose? What was the solution to this type of error? How did it work? What state information was involved? Where did the state information reside, and why?

Transmission Control Protocol (TCP)

10 11. The output on the next page shows a `tcpdump` trace (similar to WireShark) of the network packets exchanged between two computers on a network. Use your knowledge of TCP and IP to answer the following ten questions.

(a) (1 mark) What application-layer protocol is (likely) being used for this conversation?

(b) (1 mark) What is the IP address of the client?

(c) (1 mark) What is the Round-Trip Time (RTT) between the client and the server?

(d) (1 mark) How much application-layer payload is in the client's first data packet?

(e) (1 mark) What is the TCP Initial Sequence Number (ISN) proposed by the server?

(f) (1 mark) What is the Maximum Transmission Unit (MTU) size on this network?

(g) (1 mark) What is the Maximum Segment Size (MSS) used by the server's TCP?

(h) (1 mark) In total, how many bytes of application-layer data does the server send?

(i) (1 mark) Which end initiates the closing of this TCP connection: client or server?

(j) (1 mark) In total, how long did this conversation last?

```
Time(s) SourceIP   DestinationIP Size TCP SPort DPort SeqNum  AckNum Window Flags
-------------------------------------------------------------------------------
29.884 192.168.1.9  136.159.5.17 44 TCP 1035 80 133227 0 win: 32768 S
29.886 136.159.5.17  192.168.1.9 44 TCP 80 1035 3310607972 133228 win: 24820 SA
29.888 192.168.1.9  136.159.5.17 40 TCP 1035 80 133228 3310607973 win: 32768 A
29.948 192.168.1.9  136.159.5.17 418 TCP 1035 80 133228 3310607973 win: 32768 PA
29.952 136.159.5.17  192.168.1.9 40 TCP 80 1035 3310607973 133606 win: 24820 A
29.955 136.159.5.17  192.168.1.9 329 TCP 80 1035 3310607973 133606 win: 24820 PA
29.959 136.159.5.17  192.168.1.9 1500 TCP 80 1035 3310608262 133606 win: 24820 A
29.960 136.159.5.17  192.168.1.9 1500 TCP 80 1035 3310609722 133606 win: 24820 PA
29.962 192.168.1.9  136.159.5.17 40 TCP 1035 80 133606 3310609722 win: 31019 A
29.970 136.159.5.17  192.168.1.9 1500 TCP 80 1035 3310611182 133606 win: 24820 A
29.972 136.159.5.17  192.168.1.9 1500 TCP 80 1035 3310612642 133606 win: 24820 A
29.972 192.168.1.9  136.159.5.17 40 TCP 1035 80 133606 3310612642 win: 28099 A
29.973 136.159.5.17  192.168.1.9 429 TCP 80 1035 3310614102 133606 win: 24820 FA
29.974 192.168.1.9  136.159.5.17 40 TCP 1035 80 133606 3310614492 win: 26250 A
30.072 192.168.1.9  136.159.5.17 40 TCP 1035 80 133606 3310614492 win: 26250 A
30.136 192.168.1.9  136.159.5.17 40 TCP 1035 80 133606 3310614492 win: 31370 A
30.141 192.168.1.9  136.159.5.17 40 TCP 1035 80 133606 3310614492 win: 0 F
```

Internet Protocol (IP)

10 12. The diagram below shows the header format for an Internet Protocol (IP) datagram. Use your knowledge of IP and the diagram to answer the questions below.

<table>
<tr><td>Version</td><td>Type</td><td colspan="2">Length</td></tr>
<tr><td colspan="2">Identification</td><td>Flags</td><td>Offset</td></tr>
<tr><td>TTL</td><td>Protocol</td><td colspan="2">Checksum</td></tr>
<tr><td colspan="4">Source Address</td></tr>
<tr><td colspan="4">Destination Address</td></tr>
<tr><td colspan="4">Options</td></tr>
<tr><td colspan="4">DATA</td></tr>
</table>

(a) (1 mark) What is the typical size of the header for an IPv4 datagram?

(b) (1 mark) How is the 16-bit IP checksum field calculated?

(c) (2 marks) How is the TTL field used on the Internet? What purpose does it serve?

(d) (2 marks) Which fields are needed for IP fragmentation? How does it work?

(e) (2 marks) Which field is used for IP congestion control? How does it work?

(f) (2 marks) Among the remaining fields not yet discussed, which is your favourite, and why? What does it do, and how?

*** THE END ***