

CPSC 441
COMPUTER NETWORKS
FINAL EXAM

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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 120-minute exam, with a total of 80 marks. There are 18 questions, and 10 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!

Student Name: _____

Student ID: _____

Score: _____ / 80 = _____ %

Multiple Choice

Choose the best answer for each of the following 12 questions, for a total of 12 marks.

- 1 1. The two most important protocols in the Internet protocol stack are:
 - (a) DNS and WiFi
 - (b) HTTP and ARP
 - (c) SSH and FTP
 - (d) TCP and IP
 - (e) YouTube and SnapChat

- 1 2. The person who saved the Internet from TCP “congestion collapse” in 1988 was:
 - (a) Tim Berners-Lee
 - (b) Vint Cerf
 - (c) Sally Floyd
 - (d) Van Jacobson
 - (e) Jennifer Rexford

- 1 3. The person who “invented” the World Wide Web in the early 1990’s was:
 - (a) Tim Berners-Lee
 - (b) Vint Cerf
 - (c) Dina Katabi
 - (d) Jim Kurose
 - (e) Carey Williamson

- 1 4. In a domain name like `csg.cpsc.ucalgary.ca`, the Top-Level-Domain (TLD) is:
 - (a) `csg`
 - (b) `cpsc`
 - (c) `ucalgary`
 - (d) `ca`
 - (e) two, but not all of the above

- 1 5. The term “virtual circuit” refers to a:
- (a) connection-less approach to the design of the network layer
 - (b) connection-oriented approach to the design of the network layer
 - (c) connection-less approach to the design of the datalink layer
 - (d) connection-oriented approach to the design of the datalink layer
 - (e) none of the above
- 1 6. What service class(es) is/are supported in Asynchronous Transfer Mode (ATM) networks?
- (a) Constant Bit Rate (CBR)
 - (b) Variable Bit Rate (VBR)
 - (c) Available Bit Rate (ABR)
 - (d) Unspecified Bit Rate (UBR)
 - (e) all of the above
- 1 7. The typical Maximum Segment Size (MSS) for TCP on the Internet is:
- (a) 64 bytes
 - (b) 1024 bytes
 - (c) 1460 bytes
 - (d) 1500 bytes
 - (e) 8888 bytes
- 1 8. The most prominent new feature(s) in IPv6 compared to IPv4 is/are:
- (a) 128-bit IP addresses
 - (b) simpler header for streamlined datagram processing
 - (c) removing the need for IP datagram fragmentation
 - (d) better support for quality of service (QoS), mobility, and security
 - (e) all of the above

- 1 9. Routers and switches are similar in that they both:
- (a) are connection-oriented
 - (b) use BGP
 - (c) are manufactured by Microsoft
 - (d) start with the letter “r”
 - (e) operate in a store-and-forward fashion, using a “forwarding table”
- 1 10. Routers and switches are different because:
- (a) routers operate at the Network Layer, while switches operate at the Datalink Layer
 - (b) switches operate at the Network Layer, while routers operate at the Datalink Layer
 - (c) routers are for wired networks, while switches are for wireless networks
 - (d) switches are for wired networks, while routers are for wireless networks
 - (e) this is a trick question, because they are actually the same!
- 1 11. In IEEE 802.11 WiFi wireless networks, the link-layer protocol:
- (a) allows variable size frames
 - (b) automatically retransmits unsuccessful frames (up to a max retry limit)
 - (c) explicitly acknowledges successful frames
 - (d) uses MAC addresses in the header to identify the sender and receiver
 - (e) all of the above
- 1 12. The Cyclic Redundancy Check (CRC) used on data frames in Ethernet LANs provides:
- (a) very powerful error detection
 - (b) very powerful error correction
 - (c) very powerful error detection and error correction
 - (d) very strong encryption
 - (e) very weak encryption

Internet Protocol Stack

- 12 13. Below is a fairly random scatterplot of protocol acronyms, similar to the PowerPoint slide that we saw in early January. Using your knowledge of the Internet protocol stack, **circle any five** of these acronyms, and **copy them** into the relevant spaces given below, making sure to identify at least one protocol for each layer. Please write the **full name** of the protocol (i.e., expand its acronym), and provide at most **one sentence** describing what that protocol does in the Internet protocol stack.

TCP CSMA/CD SLIP MAC DNS
UDP PCM IPv4 ATM OFDM
IPv6 WiFi MIMO UDP PLCP
HTTP DHCP SSH NNTP FDM
CSMA/CA SMTP QAM FTP FDDI
POP ARP IMAP ICMP
RIP CDMA OSPF HTTPS
TDM VLAN BGP PPP

Layer 5: Application Layer (2 marks)

Example protocol:

What it does:

Layer 4: Transport Layer (2 marks)

Example protocol:

What it does:

Layer 3: Network Layer (2 marks)

Example protocol:

What it does:

Layer 2: Datalink Layer (2 marks)

Example protocol:

What it does:

Layer 1: Physical Layer (2 marks)

Example protocol:

What it does:

Bonus (2 marks)

One other protocol from the list above that I know is:

It belongs to layer:

What it does:

Networking Concepts and Definitions

12 14. For each of the following pairs of terms, **explain each term**, making sure to identify the similarities (if any) and the **key differences** between the two terms.

(a) (3 marks) “forwarding” and “routing”

(b) (3 marks) “DHCP” and “NAT”

(c) (3 marks) “Medium Access Control (MAC)” and “Logical Link Control (LLC)”

(d) (3 marks) “Ethernet” and “WiFi”

Routing Protocols

- 12 15. The current Internet uses several different mechanisms and/or protocols to deliver IP datagrams from a source host to a destination host. In class, we studied several of these protocols, as well as the design of Internet routing as a whole.
- (a) (3 marks) One of the biggest challenges in Internet routing is making routing work at the large scale of the Internet, with over a billion IP-addressable devices. What are the three main keys to making Internet routing scalable?

 - (b) (3 marks) What is an **Autonomous System**? What role does an AS play in Internet datagram delivery?

 - (c) (2 marks) Give an example of an **intra-AS** routing protocol, and provide a sentence or two to describe its operation.

 - (d) (2 marks) Give an example of an **inter-AS** routing protocol, and provide a sentence or two to describe its operation.

 - (e) (2 marks) What is the **Address Resolution Protocol**? What role does ARP play in Internet datagram delivery?

Networking Details

10 16. The output below shows the result of a **tracert** command. Use your knowledge of Internet protocols to answer as many of the following questions as you can.

- (a) (2 marks) What protocol is used to solicit the routing information displayed below? Be as specific as possible.
- (b) (2 marks) How many routing hops does it take to reach the destination host? What is the approximate round-trip time (RTT) for this network path?
- (c) (2 marks) List the IP address and name for any device on the U of S network.
- (d) (2 marks) Give an example of a private IP address that is visible within this trace.
- (e) (2 marks) What is the most unusual or anomalous feature evident in this specific trace? Why is it unusual?

```
% traceroute cs.usask.ca
traceroute to cs.usask.ca (128.233.236.236), 30 hops max, 60 byte packets
 1 deptNFSgate (172.17.10.1)  0.315 ms  0.304 ms  0.291 ms
 2 10.58.48.1 (10.58.48.1)  0.843 ms  0.835 ms  0.902 ms
 3 10.16.18.1 (10.16.18.1)  0.459 ms  0.457 ms  0.450 ms
 4 10.16.18.4 (10.16.18.4)  0.283 ms  0.249 ms  0.244 ms
 5 10.16.17.1 (10.16.17.1)  0.571 ms  0.519 ms  0.552 ms
 6 10.59.226.26 (10.59.226.26)  0.446 ms  0.418 ms  0.392 ms
 7 h74.gvpvn.ucalgary.ca (136.159.199.74)  2.597 ms  2.596 ms  2.655 ms
 8 h66-244-233-17.bigpipeinc.com (66.244.233.17)  28.075 ms  29.477 ms  27.701 ms
 9 h66-244-233-30.bigpipeinc.com (66.244.233.30)  0.939 ms  0.933 ms  0.890 ms
10 clgr2rtr1.canarie.ca (205.189.32.212)  0.890 ms  0.887 ms  1.043 ms
11 edmn1rtr1.canarie.ca (205.189.32.168)  7.533 ms  7.500 ms  6.619 ms
12 sask1rtr1.canarie.ca (205.189.32.189)  11.547 ms  11.506 ms  11.512 ms
13 srnet-reg.srnet.ca (205.189.32.221)  11.441 ms  11.615 ms  11.546 ms
14 208.75.72.83 (208.75.72.83)  13.666 ms  11.837 ms  11.759 ms
15 128.233.16.2 (128.233.16.2)  11.727 ms  13.569 ms  11.598 ms
16 cs.usask.ca (128.233.236.236)  13.869 ms  13.833 ms  12.118 ms
```

Medium Access Control (MAC) Protocols

- 12 17. Within the Data Link Layer, we studied a variety of Medium Access Control (MAC) protocols to regulate access to a broadcast channel shared by many stations.
- (a) (4 marks) If there is a fixed number of stations, and they always have data to send, then **static channel allocation** protocols make the most sense. List **two examples** of static channel allocation protocols, and briefly describe how each works.
- (b) (6 marks) If the number of stations vary, and the stations are unpredictable (i.e., bursty) in their data transmission needs, then **random channel access** protocols make sense. List any **three examples** of dynamic random access protocols, and provide a very brief description how each operates.
- (c) (2 marks) A third alternative for MAC protocol design is **turn-taking** protocols. Give **one example** of a turn-taking protocol, and briefly describe how it works.

The Future Internet

- 10 18. The Internet has grown and evolved in many different ways over the past few decades, and will continue to do so in the decades ahead.
- (a) (4 marks) In your opinion, what is the **single greatest challenge** facing the future of the Internet? Why is this issue a challenge, and why is it an important one to solve?
- (b) (6 marks) What are some approaches to solving the challenge that you identified? Give at least **two ideas for solutions** to the problem. Make sure to clarify whether these approaches are technical (e.g., network architecture, protocol design, international standards, etc.) non-technical (e.g., political, economic, social, etc.), or a combination of both.

*** THE END ***