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. One of the early pioneers of the TCP/IP protocol stack on the Internet was:

(a) Tim Berners-Lee

(b) Vint Cerf

(c) Carey Williamson

(d) Jim Kurose

(e) Jennifer Rexford

1 2. The main difference between HTTP and HTTPS is:

(a) HTTP is for IPv4, while HTTPS is for IPv6

(b) HTTP uses UDP, while HTTPS uses TCP

(c) HTTP uses TCP, while HTTPS uses UDP

(d) HTTP is unencrypted, while HTTPS is encrypted

(e) none of the above

1 3. A distinctive feature of Asynchronous Transfer Mode (ATM) networks is:

(a) a "best effort" datagram service model

(b) fixed-size 53-byte packets called "cells"

(c) 24-hour online access to the banking network each day

(d) monthly service charges for each cheque or withdrawal

(e) all of the above

1 4. A typical router in the core of the Internet has:

(a) multiple network interfaces, each with its own IP address

(b) a switching fabric between its input ports and output ports

(c) buffers to hold a queue of packets at input or output ports

(d) a scheduling algorithm to determine which queued packet goes next

(e) all of the above

1 5. On classic Ethernet, the Maximum Transmission Unit (MTU) for an IP datagram is:

(a) 64 bytes

(b) 1024 bytes

(c) 1500 bytes

(d) 8192 bytes

(e) 65536 bytes

1 6. Switched Ethernet is superior to shared Ethernet because:

(a) it isolates each station into its own collision domain

(b) each LAN segment can have different link speeds

(c) the Ethernet switch does selective forwarding between LAN segments

(d) the Ethernet switch understands and uses CSMA/CD on each LAN segment

(e) all of the above

1 7. The Internet Control Message Protocol (ICMP) is used by:

(a) Web and email applications

(b) FTP and email applications

(c) SNMP and NTP

(d) `ping` and `traceroute`

(e) DNS and ARP

1 8. In the Internet Protocol (IPv4), datagrams can be:

(a) lost enroute to their destination

(b) delayed enroute to their destination

(c) corrupted enroute to their destination

(d) successfully delivered to their destination

(e) all of the above

1 9. In a "Class B" IP address like 136.159.5.20, the network ID portion is:

(a) 8 bits long

(b) 16 bits long

(c) 24 bits long

(d) 32 bits long

(e) none of the above

1 10. In Classless Inter-Domain Routing (CIDR), the network ID in an IPv4 address is:

(a) always 8 bits long

(b) always 16 bits long

(c) always 24 bits long

(d) always 32 bits long

(e) none of the above

1 11. The key advantage of OSPF over RIP is:

(a) support for hierarchical management of a very large AS

(b) seamless integration of intra-AS and inter-AS routing

(c) dynamic switching between Distance Vector and Link State approaches

(d) dynamic switching between infrastructure mode and ad hoc mode

(e) a shorter acronym to memorize

1 12. The textbook authors refer to the Border Gateway Protocol (BGP) as:

(a) "the glue that holds the Internet together"

(b) "the most complicated routing protocol ever invented"

(c) "a top 10 networking research problem"

(d) "good news travels fast; bad news travels slowly"

(e) "this slide is VERY important"

Networking Concepts and Definitions

12 13. 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) "DNS" and "ARP"

(b) (3 marks) "IPv4 address" and "MAC address"

(c) (3 marks) "Internet checksum" and "Cyclic Redundancy Check (CRC)"

(d) (3 marks) "video frame" and "Ethernet frame"

Network Layer

12 14. The goal of Internet routing is to deliver IP datagrams from a source host to a destination host. In class, we discussed the logical separation of the Network Layer into the data plane and the control plane, as well as the emerging paradigm of Software-Defined Networking (SDN). Use your knowledge of the Network Layer to answer the following questions.

(a) (3 marks) What is the **data plane**? What key function(s) take place in the data plane? At what time scale does it operate?

(b) (3 marks) What is the **control plane**? What key function(s) take place in the control plane? At what time scale does it operate?

(c) (2 marks) What are the two main similarities between traditional Internet routing and the SDN approach to Internet routing?

(d) (4 marks) What are the four main differences between traditional Internet routing and the SDN approach to Internet routing?

Logical Link Control (LLC) Protocols

12 15. There are two popular technologies for Local Area Network (LAN) design, namely IEEE 802.3 Ethernet and IEEE 802.11 WiFi. Use your knowledge of these technologies to answer the following questions.

(a) (3 marks) What Datalink Layer service model is provided by each of these LAN technologies? How are they similar? How are they different?

(b) (3 marks) List three similarities about LLC frames in Ethernet and WiFi.

(c) (2 marks) Which of these two LAN technologies has the higher bit error rate, and why?

(d) (2 marks) Which LAN technology provides better support for mobile users, and how?

(e) (2 marks) List and explain **any two other features** of WiFi technology that are not available (or even possible) in Ethernet LANs.

Medium Access Control (MAC) Protocols

12 16. 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.

For each of the following MAC protocols, provide a brief description (either algorithmic or conceptual) of how it works. Where possible, clarify the new features in each protocol that improve upon the MAC protocols earlier in the list.

(a) (3 marks) Pure ALOHA

(b) (3 marks) Slotted ALOHA

(c) (3 marks) CSMA

(d) (3 marks) CSMA/CD

Internet Protocol Performance

10 17. Many Internet protocols use **caching** of "soft state" information to improve protocol performance. That is, the protocol works correctly even without cached state information, but is much faster when this soft state information is already present.

(a) (6 marks) Among the many protocols that we studied in class, give **three examples** of different protocols or layers that use caching of state information. Make sure to clarify **what** information is cached, **where** it is cached (e.g., client side, server side, or elsewhere in the network), **why** it is cached (i.e., how it helps improve performance). and **how long** it is cached (e.g., seconds, minutes, hours, days).

(b) (4 marks) Give **one other example** of an Internet protocol (past, present, or future) whose performance and/or scalability could be improved through the use of cached state information. Identify the layer at which this protocol operates, and why caching would be potentially useful. Again, please clarify what information is being cached, where it is being cached, why, and how long.

Future Networked Systems

10 18. A recent proposal from researchers at Carnegie Mellon University (CMU) is to get rid of traditional traffic lights at city intersections, and instead use the wireless communication capabilities of future self-driving cars to dynamically negotiate and regulate vehicular traffic flow through intersections. By doing so, they claim that they can improve traffic flow, and reduce urban commute times by about 30%.

(a) (2 marks) Do you think that this approach is a **good idea** or a **bad idea**? Why?

(b) (3 marks) Given your knowledge of wireless networking, what are some of the technical challenges with this new approach? How could these be overcome?

(c) (3 marks) Given your knowledge of flow control and congestion control, what are some of the technical challenges with this new approach? How could these be overcome?

(d) (2 marks) What other potential challenges (technical or non-technical) do you see with this new approach? How could these be overcome?

*** THE END ***