CPSC 441
COMPUTER COMMUNICATIONS

FINAL EXAM

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University of Calgary
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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 75 marks. There are 18 questions, and 9 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: _____ / 75 = _____ %

Multiple Choice

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

1 1. The protocol used to map from a human-readable host name to an IP address is:

(a) Domain Name Service (DNS)

(b) Dynamic Host Configuration Protocol (DHCP)

(c) Address Resolution Protocol (ARP)

(d) Reverse Address Resolution Protocol (RARP)

(e) none of the above

1 2. In large-scale client-server media streaming systems like YouTube:

(a) buffering is often needed before video playback can begin

(b) Content Distribution Networks are often used to move content closer to users

(c) TCP is often used for streaming in order to get through firewalls

(d) all of the above

(e) none of the above

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

(a) a datagram network service model with fixed-size packets

(b) a datagram network service model with variable-size packets

(c) a virtual circuit network service model with fixed-size packets

(d) a virtual circuit network service model with variable-size packets

(e) all of the above

1 4. In IPv4, IP fragmentation is most likely to occur when:

(a) a large datagram transits between networks with different speeds

(b) a large datagram transits between networks from different Autonomous Systems

(c) a large datagram transits between networks with different MTU sizes

(d) a large datagram transits from a wired network to a wireless network

(e) none of the above

1 5. In TCP/IP on the Internet, a transport-level connection is determined based on:

(a) IP source address

(b) IP destination address

(c) TCP source port

(d) TCP destination port

(e) all of the above

1 6. In the original TCP slow start algorithm:

(a) the initial congestion window size is one segment (1 MSS)

(b) the congestion window size doubles every Round Trip Time (RTT)

(c) `ssthresh` and `cwnd` are re-adjusted after every packet loss episode

(d) all of the above

(e) none of the above

1 7. A Network Interface Card (NIC) obtains its MAC-layer address:

(a) using the Domain Name Service (DNS)

(b) using the Dynamic Host Configuration Protocol (DHCP)

(c) using the Address Resolution Protocol (ARP)

(d) when the device is manufactured

(e) none of the above

1 8. Within the data link layer, the two sub-layers from top to bottom are:

(a) Logical Link Control and Medium Access Control

(b) Medium Access Control and Logical Link Control

(c) Internet Control Message Protocol and Dynamic Host Configuration Protocol

(d) Dynamic Host Configuration Protocol and Internet Control Message Protocol

(e) none of the above

1 9. The maximum achievable success rate on a Pure ALOHA network is approximately:

(a) 18%

(b) 37%

(c) 55%

(d) 90%

(e) none of the above

1 10. The use of Carrier Sense Multiple Access (CSMA) protocols:

(a) reduces the need for TCP congestion avoidance and control

(b) eliminates the need for TCP congestion avoidance and control

(c) reduces the number of collisions on the shared channel

(d) eliminates collisions on the shared channel

(e) none of the above

1 11. Gigabit Ethernet links can be used successfully in wide-area networks if:

(a) the number of stations per network link is increased

(b) the number of stations per network link is decreased

(c) the speed of light is increased

(d) the speed of light is decreased

(e) none of the above

1 12. The most amusing thing in CPSC 441 this year was:

(a) hamburgers on Web pages

(b) HTTP cookies

(c) flow control Friday

(d) IP over ATM

(e) this exam question

Protocol Stack

10 13. The diagram below shows the Internet protocol stack that we studied in CPSC 441. On each side of the diagram is a randomized list of some of the protocols that we studied this semester. For each protocol, **draw an arrow** clearly indicating the layer of the protocol stack with which it is associated.

Protocol	Layer	Protocol
UDP	Application	DHCP
ALOHA	Transport	DNS
HTTP	Network	FDM
IP	Data Link	IMAP
TCP	Physical	ICMP

Peer-to-Peer (P2P) Systems

8 14. In the BitTorrent (BT) file sharing system, large files are split into multiple pieces, with the pieces obtained independently in order to reconstruct the downloaded file.

(a) (3 marks) Why does BT use a piece-based approach? Give at least two reasons.

(b) (2 marks) What is the typical size of a piece? Why is this size appropriate?

(c) (3 marks) What additional challenges arise for file sharing applications on the Internet? How are these addressed, if at all?

Networking Concepts and Definitions

12 15. 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) "datagram" and "virtual circuit"

(b) (3 marks) "Autonomous System (AS)" and "VLAN"

(c) (3 marks) "error detection" and "error correction"

(d) (3 marks) "Ethernet hub" and "Ethernet switch"

IP Addressing and Routing

12 16. Host-to-host routing of IP datagrams on the Internet is quite complicated. Use your knowledge of IP addressing and routing to answer the following questions.

(a) (3 marks) What is *intra-domain routing*? Name a routing protocol in this category.

(b) (3 marks) What is *inter-domain routing*? Name a routing protocol in this category.

(c) (4 marks) Routing protocols can also be classified as *distance-vector* and *link-state* routing algorithms. What are the key differences between these two approaches? Give an example of a routing protocol in each of these categories.

(d) (2 marks) What is the *Address Resolution Protocol* (ARP)? What role (if any) does it play in the routing and delivery of IP datagrams.

Data Link Layer and Local Area Networks

10 17. At the Data Link Layer, we studied both wired and wireless examples of Local Area Network (LAN) technologies, specifically Ethernet (IEEE 802.3) and WiFi (IEEE 802.11).

(a) (3 marks) IEEE 802.11b is often referred to as "Wireless Ethernet". Give **three** examples of **similarities** between these two technologies that make the use of this term appropriate.

(b) (5 marks) Give **five** examples of key **differences** between these two technologies that make the use of this term somewhat misleading.

(c) (2 marks) Suppose that user A is downloading a 100 MB media file using TCP/IP on a classic 10 Mbps Ethernet LAN, and that user B is downloading the exact same file using TCP/IP on an 11 Mbps IEEE 802.11b WLAN. Which user would observe higher throughput? Why? State any assumptions that you make.

Network Data Rates

11 18. The Department of Physics and Astronomy (PHAS) at the University of Calgary needs you as an IT consultant for one of their networking projects. They have recently built a monitoring system for the *aurora borealis* (Northern Lights) in the Canadian Arctic. There are 12 remote cameras distributed across the north, and each takes a 1 Megabyte (1 MB) photo of the sky every 10 seconds during the night (12 hours), and writes this to a local 400 GB hard disk. About every 3 months, a graduate student from Inuvik travels by dog sled to the 12 remote cameras, collecting the full hard disks and replacing them with new ones. The full hard disks are then sent via FedEx to the U of C, arriving the very next day.
Show your work. (Note: GB = 2^{30} bytes, MB = 2^{20} bytes, Mbps = 10^6 bits per second)

(a) (3 marks) From the FedEx point of view, what is the average data transfer rate in Megabits per second (Mbps) achieved by delivering 12 full hard drives in 24 hours?

(b) (2 marks) From the U of C's point of view, what is the average data transfer rate (in Mbps) achieved when receiving 12 full hard drives every 3 months?

(c) (3 marks) The U of C is considering the use of a satellite link to transfer images on a daily basis. What data rate would be needed on the satellite link to achieve this?

(d) (3 marks) Should the U of C change to daily satellite-based transfers? If so, why? If not, why not? What other factors need to be considered in this decision?

*** THE END ***