Data Communication and Networks
Midterm: Physical, Datalink, IP layer, and DNS
CSCI-351 Fall 2018 **October 16, 2018**

You have 75 (09:30am – 10:45am) minutes to complete this exam. This is closed-book exam, but you may use both sides of one sheet of 8.5x11 paper as a "cheat sheet". The exam is worth 25% of your grade. Calculators and cell phones are NOT permitted. The exam has been designed to eliminate ambiguities. When absolutely necessary, state your assumptions and proceed. Extra credit questions are at the end of the sections. To discourage wild guessing, if you leave a question **completely blank**, *you will receive 20% of that question's credit. This does not apply to extra credit questions.*

Good luck and remember, brevity is the soul of wit.

Name: Grading Key

RIT Username: _____

Problem	Possible	Score
1	10	
2	20	
3	40	
4	15	
5	15	
6	20	
Total	120	

1. The 5 network Layer

Complete the following table by giving the following information:

1. The name of “The 5-Layer Model" (the TCP model)
2. The primary purpose of each layer.
3. Examples of encodings/protocols at each layer (unless there are no examples, in which case you may leave the space blank).

(10 pts)

Layer Name	**Purpose of the Layer**	**Example Protocols**
Application	Whatever you want.	HTTP, FTP, SMTP, POP3, DNS, SSH, SCP, BitTorrent, SSL/TLS
Transport	Demultiplexing packet streams (using port numbers). Optional features: reliable, in-order, error free delivery of packets. Flow and congestion control.	TCP, UDP
Network	Moving packets end-to-end across the whole network. Distributing and maintaining up-to-date routing information.	IPv4, IPv6
Data Link	Moving packets one-hop, between directly connected devices. Must frame packets and (sometimes) perform Media Access Control (MAC).	Ethernet, Wifi, LTE, Docsis, 2/3/4G
Physical	Encoding bits into and interpreting bits from physical media	NRZ, NRZI, Manchester, SONET

2. Data Link Layer

2a. What collision handling protocol is used by Ethernet? Briefly explain how this protocol works. (5 pts)

CSMA/CD. Before sending, a host first senses whether the line is busy. If it is not busy, the sender transmits its packet. While transmitting, the sender also listens for collisions. If a collision is detected, both senders go into exponential backoff mode by choosing a time interval to wait. After the interval expires, the sender starts the process again by first sensing the line, then sending if the line is free.

2b. What collision handling protocol is used by Wifi? Why can't Wifi use the same protocol as Ethernet? (Hint: there are two famous examples of problems that motivate the need for a different protocol.) (5 pts)

CSMA/CA. In fixed line networks, all hosts are guaranteed to hear all collisions, thus the network has nice transitive properties. However, this is not true on wireless networks; problems like hidden and exposed terminals occur when senders and receivers cannot hear each other's transmissions, and thus cannot reliably detect collisions via carrier sensing.

2c. Calculate the maximum cable length in 1,000 Mbps Ethernet environment with your process to get the answer. Assume that the light speed is $3.0 * 10^8$m/s. (If you only provide the answer without the justification, no points will be given.) (10 pts)

*$(64 * 8)$ bit * $(3 * 10^9$ m/sec) / $(2 * 10^9$ bit/sec) = 76.8m*

3. IP

3a. What does CIDR stand for? Describe two problems with class-based addressing allocation that CIDR addresses. (10 pts)

Classless Inter Domain Routing. 1) Class based addressing is inefficient: class A is too big, C is too small, B is just right, but there are only 16K available. CIDR enables granular sections of address space to be allocated of any size. 2) The routing tables with class-based addressing were too large (2.1M entries). CIDR is more efficient, resulting in 200K entries.

3b. A *default route* in a routing table is a routing rule that you would use only if no other routing rule matched the packet. How would you express a default route in CIDR notation? (5 pts)

0.0.0.0/0

3c. Briefly explain how distance vector and link state routing work. Name a protocol that implements each strategy. (10 pts)

RIP implements distance vector. In dv, routers exchange lists of the addresses they can reach, along with the distance (in hops) to that destination. Each router chooses the neighbor advertising the shortest path to a given destination as the forwarding path.

OSPF implements link state. In ls, routers exchange complete topology information: all of their neighbors and the paths they are advertising. Thus, each router ends up with complete information about the network graph, and can calculate shortest paths using Djikstra.

3d. Suppose you have a router where the routing entries are populated as below:

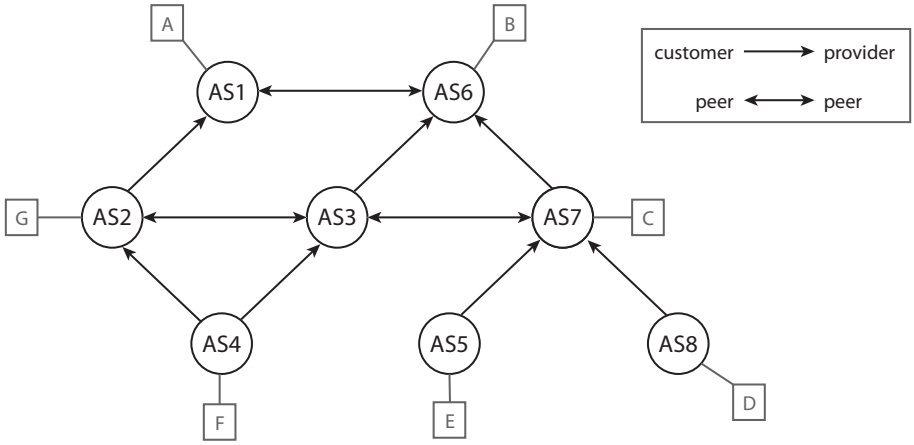
Address Pattern	Subnet Mask	Destination Router
0.0.0.0	0.0.0.0	Router 1
255.0.0.0	255.0.0.0	Router 2
128.142.0.0	255.255.0.0	Router 3
128.142.128.0	255.255.128.0	Router 4
128.142.192.0	255.255.224.0	Router 5
196.142.208.0	255.255.240.0	Router 6
128.142.222.0	255.255.255.0	Router 7

If one packet whose destination address is 128.142.222.198 comes to your router, (1) which routing entries are matched (with your justification), (2) which router do you ultimately choose to forward, and (3) why? (Please note that no points will be given if you do not explain your answer.) (15 pts)

Router 1, 3, 4, 5, 7 and choose Router 7 to forward because of Longest prefix matching

4. Inter-Routing

Consider the network shown in the following figure. Assume that if a customer has an equally good choice of providers to send outbound traffic through, the customer will pick the provider with the lowest AS number. Assume the nodes evaluate path choices using the shortest hop count metric.



4a. What path would host *F* take to reach host *B*? Justify your answer. (5 pts)

F -> AS4 -> AS3 -> AS6 -> B

4b. What path would host *D* take to reach host *G*? Justify your answer. (5 pts)

D -> AS8 -> AS7 -> AS6 -> AS1 -> AS2 -> G

4c. All traffic between *AS5* and *AS8* must transit through *AS7*. Suppose *AS5* and *AS8* want to avoid paying *AS7* for this service. What could they do to reduce their cost? (5 pts)

AS5 and AS8 could establish a peering link that would allow them to exchange traffic directly.

5. DNS

5a. What are the roles of (1) Authoritative DNS Servers and (2) DNS Resolvers? (5 pts)

Authoritative DNS servers manage and serve all the name record related to the domain name. DNS resolvers look up the name record on behalf of hosts.

5b. Briefly explain all DNS-related processes when you look up the IP address of cs.rit.edu from your laptop in the RIT network. (10 pts)

Send a DNS request to the resolver, which looks up the NS record and IP address of the .edu from the root, and iteratively lookup (must specify all the details; .edu -> .rit.edu -> cs.rit.edu)

6. Bonus points

6a. What does the PTR record do? and name one of its usage. (5 pts)

Reverse record lookup; spam filters

6b. Why is DNS vulnerable? Name one existing attack and explain how it works. (10 pts)

Plain text; cache-poisoning; send the false DNS response to the resolver and make it cached

6c. State the end-to-end argument in your own words. (5 pts)

Something along the lines of: only implement functionality in the network if it can be implemented completely, or if it offers significant performance improvements