This mid-term has 7 questions worth a total of 62 points. Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page allotted to that question. Clearly indicate your derivations and circle your final answer.

Last Name: _____

First Name: _____

1. [10 points] Short-answer questions:

1.) What type of switching did the telegraph network employ?

2.) What type of connection service does the telephone network provide?

3.) Was the ARPANET designed to serve as an internetwork from its inception?

4.) *Fill in the blank:* In networking _____ refers to what rates should be allocated to different flows.

5.) The internet consists of about 50,000 _____ systems.

6.) Can a machine with a single DNS name have multiple IP addresses?

7.) DNS accesses the SAP of which protocol?

8.) Name a form of routing employed by link-state approaches to enable global communication.

9.) What type of control is used to prevent the overflow of router buffers?

10.) What type of control is used to oversee multiple units sharing the same channel?

2. [10 points] Bandwidths, rates, throughputs. For the questions below assume that signal travel through the air at two-thirds the speed of light. **For simplicity assume that 1 KB = 10^3 B.**

   (a) [3 points] Square-wave bits are transmitted over a channel with a link bandwidth of 23-MHz, but the system requires at least two spectral lobes (the main and an adjacent one) to pass through unattenuated. What is the width of each bit bit? (Make sure to show your units!)

   (b) [2 points] A transmitter working at 17-Mbps sends a 2-KB packet through a 3000-km long fiber optic cable. What is the *propagation time* in ms (milliseconds)?

   (c) [1 point] A 15-KB file is to be sent through a network consisting of 5 links and 4 routers. Each link is a long optical fiber cable with a propagation time of 10 μs and operates at a rate of 10 Mbps. The file is broken up into an integer number of 1.2-KB packets (ignore headers). What is the packet *transmission time* at each link?

   (d) [4 points] For the system above assume that the packet transmission time is 110-μs and that each router takes 50 μs for to decide which interface to send a packet to. What is the throughput experienced in sending the file (i.e. over the 5-link network) in bps (bits-per-second)?

3. [12 points] Capacity, delay, storage. Parts (c) and (d) are on the following page. **For simplicity assume 1 KB = 10^3 B.**

(a) [3 points] You have devised a scheme whose signal power requirement comes within 10% of the theoretical error-free communication limit. What is the signal-to-noise ratio (in dB) that you need in order to achieve 200-Mbps communications over a channel with a 75-MHz bandwidth?

(b) [4 points] A router with a net (i.e. summed over all ports) data processing rate of 10-Gbps is to handle 1500 byte packets from up to 32 ports. Assuming the router has a 5.5 KB high-speed queue memory, what is the average rate per port (in Mbps) that we can sustain to accommodate average queue lengths?

(c) [2 points] A video-application is capable of processing 2500 packets per second. If an average of 2200 packets per second are arriving by how many milliseconds should I buffer the video before displaying it?

(d) [3 points] A router has 24 ports each capable of operating at 2.4 Gbps. Such a router facilitates a multitude of connections through it (multiplexed over time and ports). Assume that on average any one connection experiences 400-kbps throughput through the router and that this activity is achieved with each link operating at 13% of its maximum rate. What is the average rate that new connections arrive at the router if each connection lasts an average of 30 seconds?

4. [10 points] Internetwork addressing.

(a) [2 points] A network on the Internet has a subnet mask of 255.255.192.0. What is the maximum number of hosts that it can handle?

(b) [5 points] Consider the following router table.

Destination	Next Hop
135.46.56.0/22	If0
135.46.60.0/22	If1
192.53.40.0/23	Router 1
default	Router 2

Indicate what the router does when packets with the addresses below arrive.

1.) 135.46.63.10

2.) 135.46.57.14

3.) 135.46.52.2

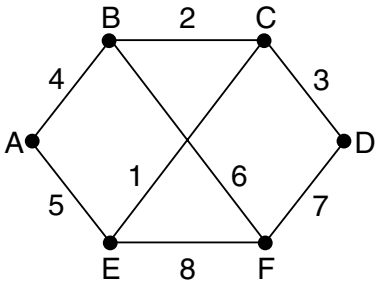
4.) 192.53.40.7

5.) 192.53.56.7

(c) [3 points] What can the following addresses be aggregated to: 57.6.96.0/21, 57.6.104.0/21, 57.6.112.0/21, 57.6.120.0/21?

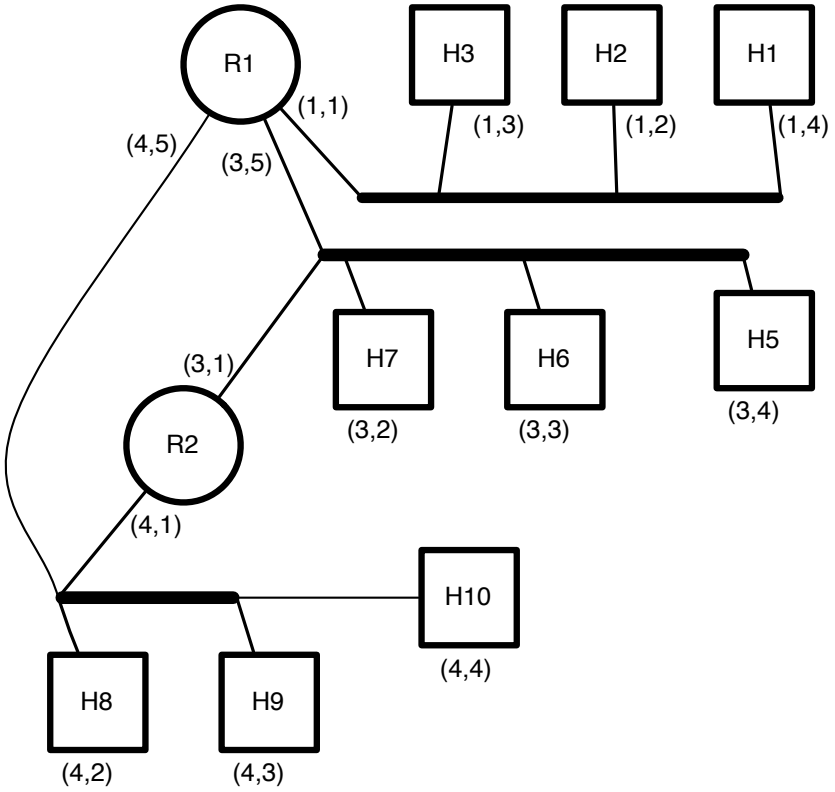
5. [9 points] Routing and topology. Part (c) of this question is on the following page.

(a) [4 points] Consider the network below (ignore the numbers shown). Distance vector routing is used, and the following vectors (denoting distances to nodes A, B, C, D, E, F, respectively) have just come in to router B: from A: (0, 3, 8, 12, 6, 2); from C: (14, 5, 0, 6, 9, 8); and from F:(7, 6, 3, 9, 4, 0). The cost of the links from B to A, C, and F, are 7, 3, and 5, respectively. What is Cs new routing table? Give both the outgoing line to use and the cost.



(b) [2 points] For the network pictured above (don't ignore the numbers shown) sketch the structure and contents of node A's link-state packed (should a routing protocol like OSPF be used). Make sure to include the fields key to making a link-state routing scheme practical.

(c) [3 points] For the network below fill out the routing table for R1 assuming that R1 is configured to directly send packets to H9.



6. [6 points] Layers, protocols, architectures.

(a) [1 point] What protocol do CDNs rely on to direct users to the right machines in their network?

(b) [1 point] Besides the peers themselves what are the two other most critical parts of a P2P network?

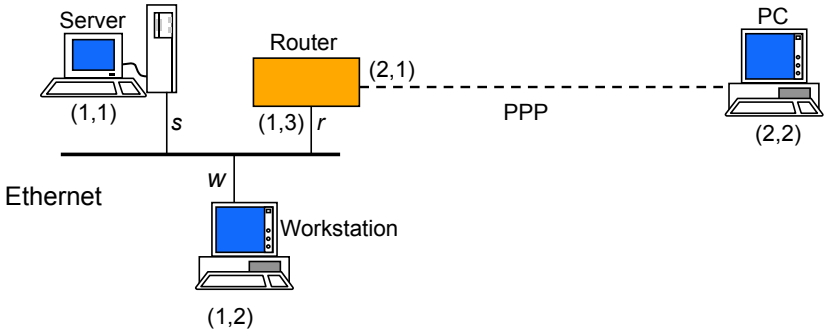
(c) [1 point] In the OSI reference model what is the name of lowest of the end-to-end layers?

(d) [1 point] Name a protocol that can be ascribed to function in the data link layer of the OSI reference model.

(e) [2 points] Imagine you need to send an email to `android@robotsky.com`. Assuming a worst case scenario (but no segment or packet or frame errors) sketch the address resolution process and state how many total UDP packets (i.e. sum up requests and responses) need to be exchanged for you to resolve the address?

7. [5 points] Frames and packets in TCP/IP.

(a) [5 points] Consider the network shown below. The IP addresses in simplified (netID, hostID) form are shown as are the physical addresses of Ethernet connections denoted by the letters, w, r, s. Sketch the frames (and just the frames) that are transmitted over the course of a communication from the PC to the workstation. In your sketches of the frames include not only the header of the frames, but also the header of the network layer packet encapsulated in the frame.



Q1

Q2

Q3

Q4

Q5

Q6

Q7

Total