

**CSCI 466 Midterm  
Networks  
Fall 2011**

**Name:** \_\_\_\_\_

This exam consists of 7 problems on the following 9 pages.

You may use your single-sided hand-written 8 ½ x 11 note sheet and a calculator during the exam. No computers or communication devices of any kind are permitted.

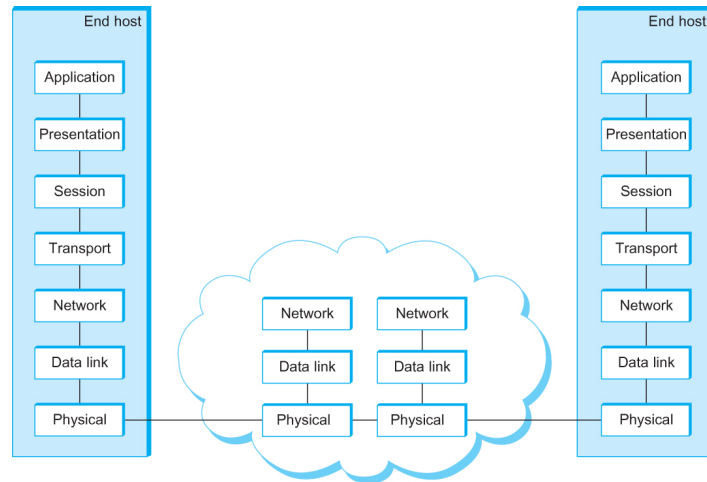
If you have a question, raise your hand and I will stop by. Since partial credit is possible, **please write legibly and show your work.**

<b>Problem</b>	<b>Points</b>	<b>Score</b>
<b>1</b>	<b>22</b>	
<b>2</b>	<b>10</b>	
<b>3</b>	<b>16</b>	
<b>4</b>	<b>10</b>	
<b>5</b>	<b>12</b>	
<b>6</b>	<b>10</b>	
<b>7</b>	<b>12</b>	
<b>Total</b>	<b>92</b>	

1) Multiple choice (22 points total, 2 points each). Circle the best single answer.

I. What is the name for the devices in the cloud in the diagram?

- a) switches
- b) routers**
- c) hubs
- d) repeaters



II. Which of the following link protocols best describes Ethernet?

- a) Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)
- b) Frequency Division Multiple Access (FDMA)
- c) Carrier Sense Multiple Access with Collision Detection (CSMA/CD)**
- d) Asynchronous Transfer Mode (ATM)

III. Which of the following is true about Ethernet networks?

- a) Switches provide greater scalability and security than hubs.**
- b) Ethernet frames have a minimize size to ensure good utilization of the network (i.e. senders would otherwise have a large overhead to send a small amount of data).
- c) When an Ethernet sender detects the media is idle it issues a jamming signal to inform other devices not to transmit. It then sends its packet.
- d) Ethernet frames contain a single 48-bit MAC address.

IV. Which of the following is true about 802.11 Wi-Fi networks?

- a) All wireless networks must use access points.
- b) Collisions can still happen when Ready to Send-Clear to Send (RTS/CTS) is used.**
- c) 802.11 frames contain a total of two MAC addresses, one for the sender and one the destination.
- d) Explicit frame acknowledgements are optional and normally not very helpful.

V. Which of the following link protocols best describes 802.11 Wi-Fi?

- a) Time Division Multiple Access (TDMA)
- b) Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)**
- c) Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
- d) Pure ALOHA

- VI. Which of the following is true about the Address Resolution Protocol (ARP)?
- a) Maps domain names (e.g. youtube.com) to IP addresses
  - b) A new host broadcasts its hardware address and the default gateway responds with an IP address.
  - c) If a host hears a request for its IP address, it responds with its hardware address.**
  - d) Hosts send ARP requests using a multicast hardware address.
- VII. Which of the following statements is true about routers?
- a) Routers must not change the IP packets they forward
  - b) Routers can arbitrarily drop packets if they want**
  - c) Routers must implement either the Border Gateway Protocol (BGP) or the Exterior Gateway Protocol (EGP).
  - d) Routers are required to reassemble fragments if the next router supports the full datagram size.
- VIII. Which of the following framing protocols uses: an initial two-byte flag value, no bit stuffing, a fixed-sized frame, and scrambles bytes using XOR?
- a) DDCMP (byte-counting)
  - b) PPP (sentinel-based)
  - c) HDLC (bit-oriented)
  - d) SONET (clock-based framing)**
- IX. If you are transmitting 1 byte packets. What network performance metric is most important?
- a) Throughput
  - b) Bandwidth
  - c) Latency**
  - d) Speed of light in a vacuum
- X. You need to transmit a video to 10 different hosts on a large network. What type of routing would be the best fit?
- a) Multicast**
  - b) Unicast
  - c) Broadcast
  - d) Anycast
- XI. Which of the following is **NOT** a feature/advantage of IPv6?
- a) Larger address space
  - b) Flexible variable sized headers**
  - c) Autoconfiguration of hosts
  - d) Enhanced routing capabilities

**2) Physical encoding (10 points).**

- a) To transmit a bit, we could simply use a high voltage level for a 1 and a low voltage level for a 0:



What are two reasons this simple scheme is problematic?

- 1) **Baseline wander – hard to tell threshold for what is a 0 and what is a 1**
- 2) **Synchronization – hard to keep clocks in synch**

- b) 100 Mbps Ethernet uses Non-Return to Zero Inverted (NRZI) and 4B/5B encoding. Briefly describe each encoding scheme and describe why each is helpful.

**NRZI – A binary 1 is coded as a transition in signal level (from 0 to 1 or 1 to 0). A binary 0 is coded as no change in signal. This helps avoid long strings of 1's from causing the problems described in a).**

**4B/5B – Encode each nibble of 4 bits as a 5 bit code. The code is chosen so there will never be a run of more than three consecutive 0's. Combined with NRZI it avoids the problems described in a).**

- c) 10 Gigabit Ethernet uses 64B/66B, what is its advantage over 4B/5B?

**4B/5B requires 1 extra bit for each 4 bits to be transmitted, thus 80% efficient.**

**64B/66B requires 2 extra bits for each 64 bits, thus 97% efficient.**

**3) Network performance (16 points).**

- a) You record a 2 second video on your phone. The video is 320 x 240 resolution, 3 bytes/pixel, 15 frames per second. Assume no data compression. Calculate the file size in bytes.

$$15 \text{ frames / sec} * (320 * 240 \text{ pixels}) / \text{frame} * 3 \text{ bytes / pixel} * 2 \text{ sec} = 6,912,000 \text{ bytes}$$

- b) Assume you can transmit the video continuously with no connection setup and no other overhead. Your phone's network connection has a bandwidth of 512 Kbps and the Round Trip Time (RTT) to the destination server is 200 ms. How long will it take for the entire video to reach their server?

$$6,912,000 \text{ bytes} * 8 \text{ bits / byte} * 1 \text{ sec} / 512,000 \text{ bits} = 108 \text{ sec}$$

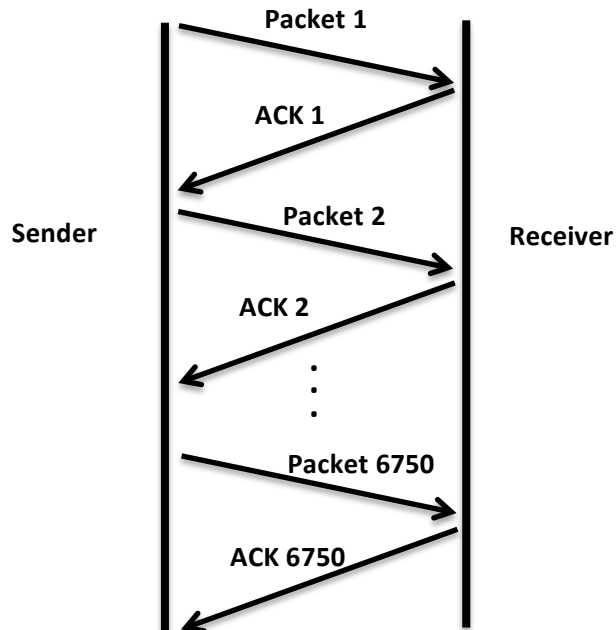
**Add in ½ RTT for last bit on wire to propagate to server:**

$$108 \text{ sec} + 0.1 \text{ sec} = 108.1 \text{ sec}$$

(continued on next page)

- c) Instead of being able to send packets continuously, assume you use the stop-and-wait protocol with 1KB packets and no packet overhead. Assume no transmission errors occur. How many total packets are required to send the video? Draw a timeline diagram showing the first two packets of the transmission and the last packet.

$$6,912,000 \text{ bytes} * 1 \text{ packet} / 1024 \text{ bytes} = 6750 \text{ packets}$$



- d) Given the setup described in c) and a bandwidth of 512 Kbps with an RTT of 200 ms, how long does it take for your entire video to reach the destination server?

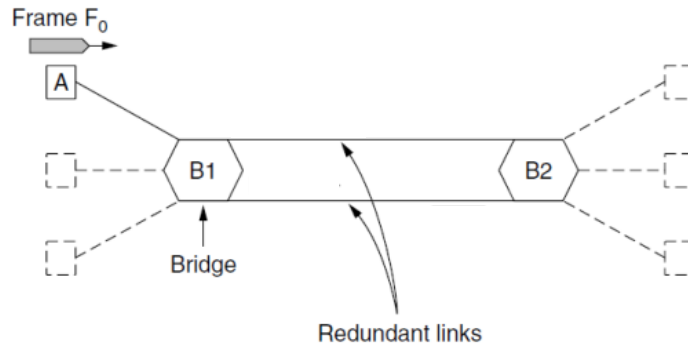
$$1024 \text{ bytes} * 8 \text{ bits} / \text{byte} = 8192 \text{ bits} / 512,000 \text{ bits per second} = 16 \text{ ms}$$

$$(\text{RTT} + 16 \text{ ms}) * 6749 \text{ packets} + (\frac{1}{2} \text{ RTT} + 16 \text{ ms}) * 1 \text{ packet}$$

$$(216 \text{ ms} * 6749 + 116 \text{ ms}) * 1 \text{ sec} / 1000 \text{ ms} = 1457.9 \text{ sec}$$

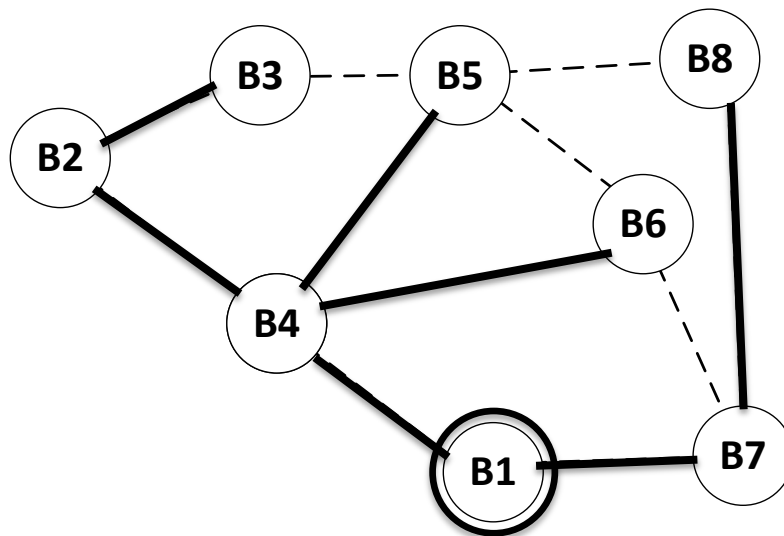
**4) Switching (10 points).**

- a) In the network below, a bridge B1 received a packet from A to an unknown destination D. If B1 and B2 did **NOT** use the spanning tree algorithm, describe the problem that would result.

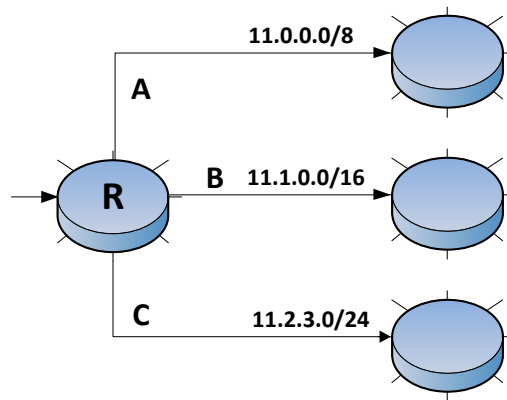


**Packets would get stuck in a loop going between B1 and B2 (at least until the packets die or B1/B2 learn where D actually is).**

- b) The power has just been restored to the local area network (LAN) shown below. Hosts (not shown) are directly connected to the bridges (i.e. the network is entirely switched with no shared network segments). Circle the bridge that will (after a period of time) be designated as the root bridge. Fill in solid lines between bridges that are part of the spanning tree.



5) IP prefixes and forwarding (12 points). Consider the following three routers where router R has outgoing interfaces A, B, and C:



a) How many IP addresses does the prefix 11.2.3.0/24 represent?

$$2^8 = 256$$

b) List the forwarding table entries for router R. A new packet has just arrived at R. Describe how R uses its forwarding table to decide what to do with the packet.

Prefix	Next hop
11.2.3.0/24	C
11.1.0.0/16	B
11.0.0.0/8	A

**A packet will be examined to find the longest matching prefix in the forwarding table.**

c) Which outgoing interface does R use for a packet with destination 11.2.3.1?

**C**

d) Which outgoing interface does R use for a packet with destination 11.1.2.3?

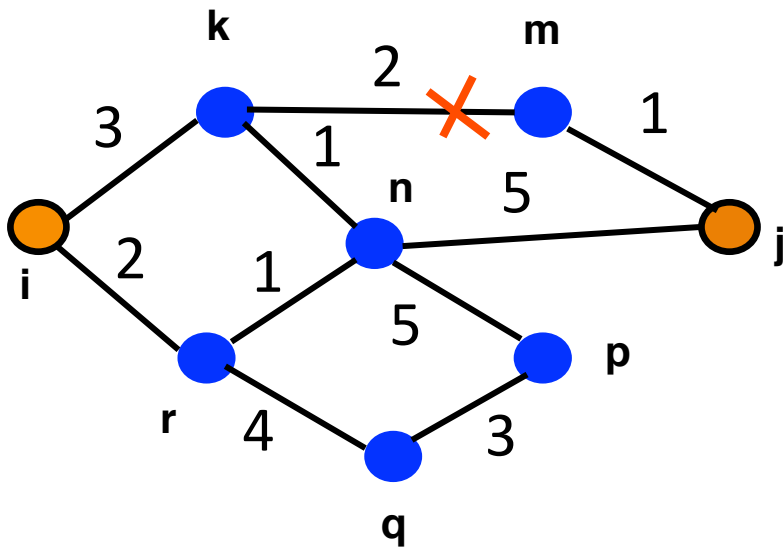
**B**

e) Which outgoing interface does R use for a packet with destination 11.2.4.5?

**A**



**6) Intradomain routing** (10 points). Assume a shortest-path, link-state routing protocol is running on the following network, where the numbers correspond to link weights:



a) Suppose the link between nodes k and m fails. Before the failure, what is the shortest path from node i to node j? What is the new path after the failure (after the routing protocol converges)?

**before:  $i - k - m - j$  ( $3 + 2 + 1 = 6$ )**

**after:  $i - r - n - j$  ( $2 + 1 + 5 + 1 = 9$ )**

b) A transient forwarding-loop might occur during protocol convergence. Which two nodes are involved in the loop? If convergence takes a long time, what might happen to a packet stuck in the loop?

**k and n**

**The packet may out live its TTL and be dropped. Or the packet may escape once routing converges.**

**7) Interdomain routing (12 points).**

- a) How does the Border Gateway Protocol (BGP) avoid the count-to-infinity problem that plagues distance-vector protocols?

**BGP uses the path vector protocol which includes the entire path instead of only the next hop. Thus a router can detect when a path includes itself and avoid a cycle.**

- b) Give two reasons why BGP is used for Interdomain routing instead of a link-state protocol such as Open Shortest Path First (OSPF) that calculates optimal least-cost routes.

- 1) Scalability**
- 2) Enforce AS policies**
- 3) Hide details from competitors**

- c) A campus network is a multi-homed Autonomous System (AS) with connections to two tier-3 Internet Service Providers (ISPs). The border routers of the campus run BGP. Does the campus AS advertise routes learned from the first ISP to the second (and vice-versa)? Why or why not?

**No. The campus has no incentive to allow transit traffic (traffic not destined to a host at the campus) to pass through its network.**