Name ________KEY_____________

CS513/ECE506
Spring 2013
Computer Networks
Mid Term Exam
March 12, 2013

Question	Points	Score
0	1	
1	2	
2	3	
3	6	
4	5	
5	3	
6	5	
7	5	
8	5	
9	4	
10	5	
11	2	
12	2	
13	5	
14	6	
15	14	
16	18	
Total	90	

Trivia Question (1 extra credit point)

0. (a) What country will host the **2018** soccer **World Cup**?

Russia

-OR-

(b) What is the capital of **Bulgaria**?

Sofia

(2 pts.) 1. What is the difference between **circuit switching** and **packet switching**?

Circuit switching implies the need to first *set up* a dedicated, end-to-end path for the connection *before* the information transfer takes place. The resource is dedicated and not shared.
Packet switching involves a store-and-forward network where the block of transfer is a complete *packet (*a variable length block of data with a fixed upper bound). With packer switching the resource can be shared over time.

(3 pts.) 2. Explain the role and responsibilities of the **Transport Layer** in the **OSI** reference model.

Provides *reliable transparent* transfer of data between end points (hosts).
Provides *end-to-end* flow control and error recovery.

(6 pts.) 3. What is a **cookie**? Draw a diagram and use it to explain the **four components** of using **cookies** between browsers and Web server sites.

A HTTP mechanism that enable server sites to keep state information about clients.
<u>Four components:</u>

1) **cookie header line of HTTP *response* message**
2) **cookie header line in HTTP *request* message**
3) **cookie file kept on user's host, managed by user's browser**
4) **back-end database at Web site**

(5 pts.) 4. What services does **DNS** provide? Name one **protocol** that uses **DNS**. What **protocol** does **DNS** use?

DNS provides four services:

1. hostname to IP address translation

2. host aliasing

- **Aliases, where canonical name is "real" name**

3. mail server aliasing

4. load distribution

- **replicated Web servers: set of IP addresses for one host name.**

DNS used by HTTP, SMTP and FTP. DNS uses UDP.

(1 pts.) 5a. Define **attenuation**.
the reduction or loss of signal strength (power) as it is transferred across a system.

(2 pts.) 5b. Explain the problems with using **analog transmissions** to overcome **attenuation**.

Analog transmissions use amplifiers to amplify attenuation signals, but this also amplifies the noise such a series of amplifiers for a analog transmission will produce cascaded increases in the amount of noise in the transmission.

(2 pts.) 6a. Given a **16 MHz** baseband channel where **QAM-16** is used, what is the theoretical maximum achievable **Nyquist data rate** for this channel?

$C = 2H \log_2 V$ = 2x16million x $\log_2 16$ = 32 x 4 = 128 Mbps.

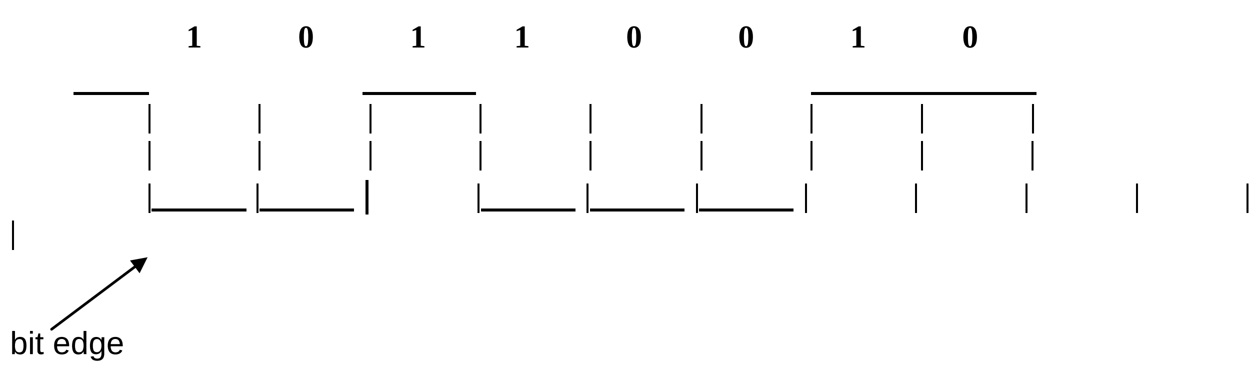
(3 pts.) 6b. Explain how **QAM-16** works.

QAM-16 = QPSK and QASK QPSK gives you four choices in phase shift while QASK gives you four choices in amplitude shifts. Multiplying the two, QAM-16 provides 16 possible symbols per modulation. i.e., V = 16

(5 pts.) 7. Explain the differences between an **Ethernet switch** and a **10BASET hub**.

Ethernet switch uses 'backward learning' at layer 2, namely it remembers the source MAC address of frames passing through and associates address with incoming port in a switch table. As table gets updated, the probability increases for parallel conversations without *collisions.* Thus mutually exclusive pairs of nodes can communicate in parallel which multiplies the potential capacity.
Ethernet hub is simply a repeater which broadcasts out on all output lines which implies many collisions possibly (essentially standard Ethernet)

(4 pts) 8a. Assume that the voltage level at time t = 0 is **high**, fill in the diagram below to show the **NRZI encoding** for the bit stream **10110010**.



(1 pt.) 8b. What advantages does **NRZI** have over using **NRZL**?

NRZI is a differential encoding *scheme* (i.e., the information transmitted is terms of comparing adjacent signal elements

(4 pts) 9. Draw a diagram and explain how a **T1 carrier** works.

(2 pts.) 10a. Why is **1500 nm** optical fiber better than **850 nm** optical fiber as a transmission medium for network traffic?

Using a higher wavelength (1500 nm) means the attenuation will be lower and the optical signal can travel farther before being attenuated beyond recognition. This means optical repeaters can be spaced farther apart with 1500nm fiber.

(3 pts.) 10b. **FiOS** is a **Passive Optical Network** (**PON**). What are the advantages and disadvantages of **PONs** versus **AONs** for optical transmissions into residences?

AONs:

- **Uses electrical powered switches**
- **More range**
- **Less reliable**

PONs:

- **Optical splitters do not need electrical power.**
- **Hard to isolate failure**
- **Transmission speed may be slower during peak hours.**

(2 pts.) 11. What are the advantages of transmitting **frames** at the data link layer instead of sending **asynchronous single-character** transmissions?

Single character transmissions can require overhead with *start and stop bits* (2.5 bits per 8 bit character).

Frames uses *overhead delimiter bytes* at the beginning/end of the frame, but the longer the frame the lower is the percentage of overhead.

(2 pts.) 12. Perform the **bit stuffing** procedure discussed in class on the following input stream of data bits:

INPUT STREAM: **1 0 1 1 1 1 1 0 1 1 1 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1**

OUTPUT STREAM: **1 0 1 1 1 1 1 0 0 1 1 1 1 0 0 1 1 1 1 1 0 1 1 1 1 1 0 1 1 0 1**

13. Receiver **R** employs $g(x) = x^4 + x^2 + 1$ as its **generating polynomial** for **CRC** error detection.

(4 pts) 13a. **R** receives the following transmitted bit stream **frame: 001000011101.**
What is the **remainder** computed by the **CRC** module in **R?**

Remainder is 0.

(1 pt.) 13b. What does **R** do with this **frame**?

R accepts frame, strips off CRC bits and forwards 00100001 to the DL layer.

(4 pts.) 14a. How does **Slotted Aloha** work? List all the assumptions made in the derivation of

$$S = G\, e^{-(1+a)G}$$

N Station transmits ONLY at the beginning of a time slot on a shared channel. Collisions can occur. Vulnerable period is one slot. All frames are the same size. Frames arrives as Poisson processes.

(2pts.) 14b. What are **S, G** and **a** in this formula?

S is normalized throughput, G is the mean offered load and a is the relative propagation time.

(14 pts.) 15. Given the following "help function" **send_frame ( )** which has "global access" to structures **s, buffer** and **next_frame_to_send** defined in **sender_NAK** below, write Tanenbaum-style pseudo-code for a **sender_NAK** and a **receiver_NAK** for a data link layer protocol to handle **unidirectional flow** over an unreliable channel. The protocol is a one-bit sliding window protocol where the receiver sends an **ACK** when a frame is transmitted correctly. If a frame is received in error, the receiver sends a **NAK** frame.

As with Tanenbaum's pseudo-code, assume **sender_NAK** and **receiver_NAK** can share global definitions and that the frame structure includes a **kind** field. **{Clearly write down any other assumptions you make!}**

Assumptions:

```
void send_frame (void)
{
s.info  = buffer;
s.seq  = next_frame_to_send;
to_physical_layer(&s);
}
```

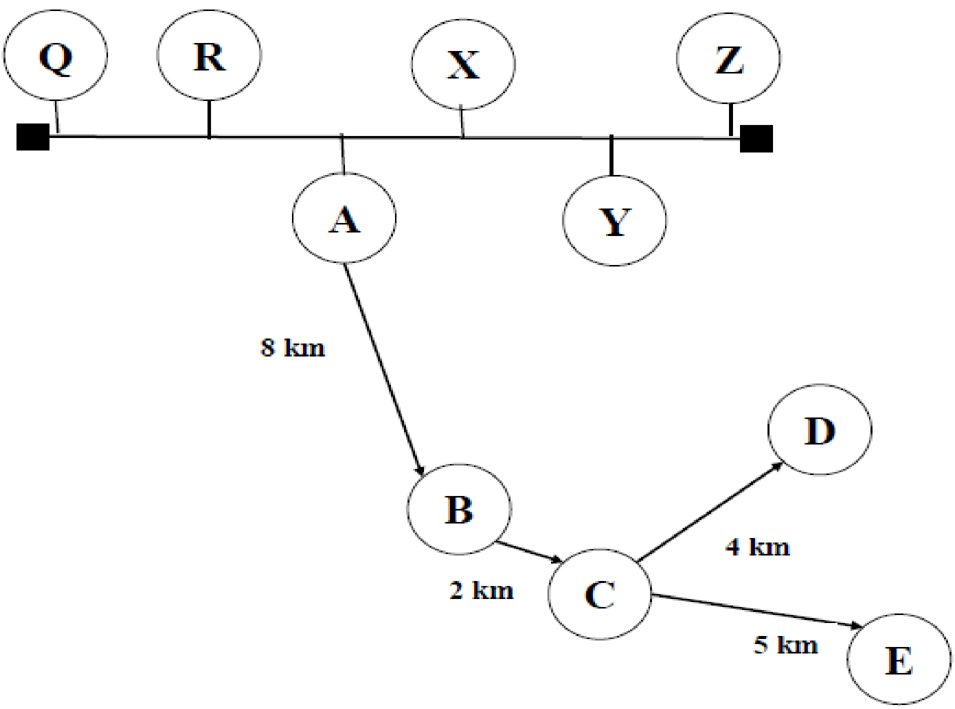
Work from the preliminary pseudo-code for sender_NAK given here:

```
#include protocol.h
#define
#typedef
```

```
 void sender_NAK (void)
{

   seq_nr next_frame_to_send;
   frame s;
   packet buffer;
   event_type event;
   next_frame_to_send = 0;

}
```

```
 void receiver_NAK (void)
{

}
```

16.



Given the internet pictured above with a propagation speed of **150 m/microsec**. on the **100BASE5** LAN and a propagation speed of **200 m/microsec.** on the store-forward packet-switched WAN where nodes **Q, R, A, X, Y** and **Z** are **equally spaced** on the Ethernet with nodes **Q** and **Z** at the opposite **maximum** possible extreme ends.

Nodes **A** to **E** are spaced on the WAN as shown with **2 Gbps** links between nodes. Assume it takes each WAN node **50 microsec.** to look up a packet's route in its routing table and that there is a **1 bit** delay for a Ethernet frame to pass through a node on the ether (excluding the sender and receiver nodes).

Assume an IP packet has **1300 bytes** and the frame header = **100 bytes** and the frame trailer = **100 bytes** on **both** the Ethernet LAN and the point-to-point WAN.

(17 pts.) 16a. How long will it take to send a frame from node **Z** to node **E** in the situation that when the frame arrives at node **C** there are **four** frames waiting to go to node **E** and **three** frames waiting to go to node **D**? Assume all frames are the same size and that there is no other traffic on the internet when the frame is sent.
{To receive full or partial credit, you MUST show all your work on the next page}

(1 pts.) 16b.What is the **relative propagation time** on the **Fast Ethernet LAN**?

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