1. True or False

T a. In stop and wait ARQ, the receiver always send an ACK frame each time it receives a frame with the wrong sequence number

F b. The BW x Delay product is the maximum # of bits/sec that can fill the "pipe"

F c. A socket is a protocol that defines the messages exchanged between the application layer and the Network Operating System

T d. Web caching maybe used to reduce the response time as experienced by the user. It may also reduce the load on the link and the load on the web server

T e. Broadcasting the ARP reply (instead of unicasting) may reduce the amount of ARP requests on the network.

F f. In Persistent HTTP, a single TCP connection can transfer multiple images or other embedded objects in on HTML page regardless of whether they all come from the same server or not

T g. Queuing delays may be reduced by increasing the transmission bit rate (R) and reducing the distance between end hosts

T h. In Statistical Multiplexing, the number of time slots in each frame is less than the number of input lines to the Multiplexer

T i. A client process can open multiple TCP connections to the same server process

F j. HTML protocol transfers files that make up pages on the world wide web

T k. ARP is a protocol used to resolve the "next hop IP address" to its MAC address.

F l. Some error detection schemes are guaranteed to detect errors for any number of flipped bits in the frame

T m. Iterative DNS queries require shorter socket connections with DNS servers than recursive DNS requests

T n. A Process X running in a server machine has a port number of 100. Two hosts A and B each send a UDP datagram to the Server with destination port #100. Both of these datagram will be directed to the same socket

F o. A DHCP server must be located on every network to assign IP addresses to DHCP clients on that network

T p. If a computer has multiple Network Interface Cards, The DHCP process must occur separately over each interface to obtain a separate dynamically assigned IP address for each interface.

T q. In the absence of any frame loss or duplication, the S&W ARQ protocol would not need any frame sequencing

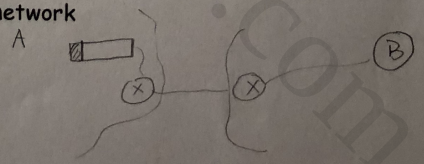
F r. To be able to recover the analog signal from its sample, the sampling period has to be at least twice the highest frequency component in the signal being sampled

T s. If an "Accept ()" command is not executed at the server, then the NOS operating system at client will return an error to the application which issue a "connect ()" command at the client.

F t. When UDP passes the datagram payload to the application, it must also specify the IP address of the source. This is not the case with TCP.

F u. Server name resolution is done by using the address ARP resolution protocol

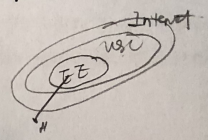
T F v. The router IP address must appear in the header of a packet sent by host A and destined to host B on another network



C

w. A host is connected to the EE department network which in turn is a part of the USC network which is in turn a part of the Internet. The largest network in which the Ethernet address of the host is unique is

MAC



a. The EE department network
b. The USC network
c. The Internet
d. None of the above

A b

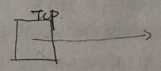
x. Which of the following functionalities must be implemented by a transport layer protocol over and above the IP? (Circle one)

TCP UDP
IP

a. Provide for End-to-end connectivity
b. Recovery from lost packets
c. Packet delivery in the same order they were transmitted
d. All of the above

B a

y. Packets of the same session may be routed through different paths in (Circle one)



a. TCP, but not UDP
b. TCP and UDP
c. UDP, but not TCP
d. Neither TCP nor UDP

C d

z. Consider different activities related to email.

m1: Send an email from a mail client to mail server SMTP SMTP
m2: Download an email from mailbox server to a mail client POP
m3: Checking email in a web browser HTTP

Which is the application layer protocol is in each activity? (Circle one)

a. m1:HTTP, m2:SMTP, m3:POP
b. m1:SMTP, m2:FTP, m3:HTTP
c. m1:SMTP, m2:POP, m3:HTTP
d. m1:POP, m2:SMTP, m3:IMAP

D= $T_p = \frac{D}{2.5\times10^8} = 5T_t = \frac{5\times}{1}$

$R = 10\times10^6$ bps.

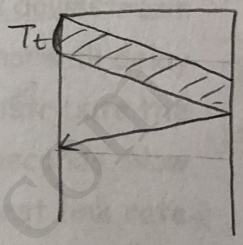
$T_t = \frac{L}{R} = \frac{1000}{10^7}$

Part 2: Quickies (every blank is worth 2 point)

1. Consider a transmission link that uses the stop and wait protocol. The ratio of the propagation delay to the transmission time is 5. Frames are transmitted at a rate of 10 Mbps and each frame is 1k bits long. Bits propagate at the speed of light (2.5×10^8 m/sec).

$\frac{T_p}{T_t} = 5$ $T_p = 5T_t$

$D = 5\times10^3 \times 2.5\times10^8 \times 10^{-7}$

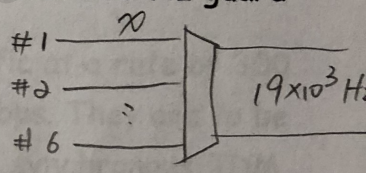


a. The length of the link is _____ meter.

b. The link efficiency (utilization) is _____ % $\frac{T_t}{T_t+2T_p}$

2. Six sources are multiplexed using FDM on a link that has a total bandwidth of 19K Hz. The maximum bandwidth for each source if there must be a 200 Hz guard band between the channels is _____ Hz

$6\times3+5\times200 = 19\times10^3$

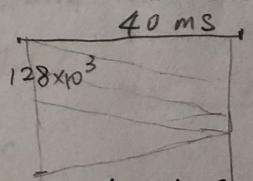


3. Node A uses 32 Byte frames to send to node B using a sliding window. The one-way propagation delay is 40 msec. The bottleneck bandwidth on the path from A to B is 128 Kbps. The optimal window size node A should use is _____.

32x8 bits

$WT_f = RTT$

$W \cdot \frac{32\times8}{128\times10^3} = \frac{80}{10^3}$



4. In a certain DLC protocol, the Flag used to indicate the start and end of the frame is 0111. Assume that Zero stuffing is used (To prevent the occurrence of the flag sequence anywhere in the frame). The data sequence is 01110110. The sender will transmit the sequence _____

5. The bit duration on a T1 line is _____ seconds 0.65 μsec

6. Suppose a movie studio wants to distribute a new movie as a digital file to 1,000 movie theaters across country using peer-to-peer file distribution. Assume that the studio and all the theaters have DSL connections with an 8 Mb/s downstream rate and a 4Mb/s upstream rate and that the file is 10 GB long. Ignore all delay components that are not specified in question. The time it takes to distribute the file to all the theaters under ideal conditions is _____ seconds. Now suppose the studio wanted to use a client-server model. The smallest link rate that is required at the studio (server) that would allow distribution of the file in under 40,000 seconds is _____ bps.

7. We have 3 information sources, two of which generate traffic at a rate of 300 bps each. The third one generates traffic at a rate of 350 bps. They are to be multiplexed using multiple-slot (each slot supporting 1 bit), synchronous TDM. Each source is active 50% of the time. Ignore any synchronization bits.

   a. The length of the TDM frame is = _____ bits

   b. The duration of the TDM frame is _____ sec

   c. The TDM frame rate is _____ frames/sec

   d. The multiplexed rate is _____ bps

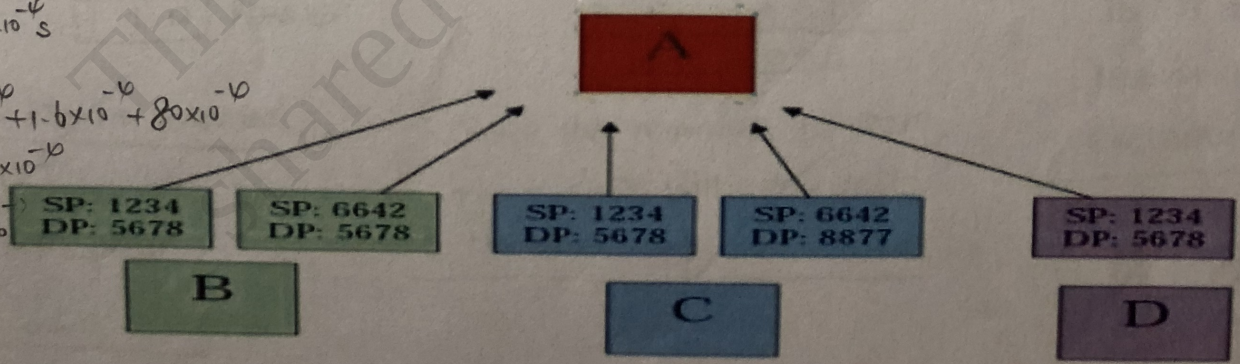
8. A video signal is 5 MHz wide. It is sampled at the Nyquist sampling rate and then quantized using 64-levels and then encoded. The bit rate of the digital stream is _____ bps

9. Assume that you have 8 input sources as follows: Three sources generates 1 Kbps (each), 75% of the time, Three sources generates 2 Kbps (each), 50% of the time and two sources generates 6 Kbps, 25% of the time. A Statistical TDM with a link utilization of 80% is used. The required data rate at the output of the MUX is _____ bps.

10. A channel with bandwidth of 4 KHz. It is desired to transmit data reliably at a rate of 50 Kbps over this channel. The minimum signal to noise ratio required is _____ dB

11. A 50 Kbyte message is to be transmitted over a 2-hop packet network. The network limits the size of the packet to 1 Kbytes. The links are error free and each has speed of 50 Mbps. Each hop is 100 Km long and the bits are transmitted at the speed of light of 2×10^8 m/sec. It will take _____ seconds for the message to get from the source to the destination. Ignore processing and queuing delays.

12. In the diagram below, nodes B, C, and D are sending messages to A with the indicated Source Port and Destination Port addresses. From this diagram, the number of Sockets A has opened is _____ (If all nodes are using UDP) and is _____ (if all nodes are using TCP)



x^5 x^3

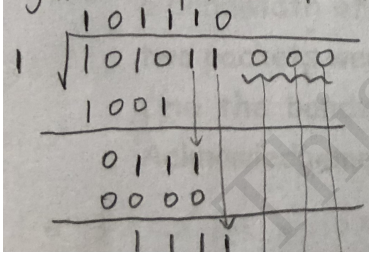
3. An FCS error detection mechanism is used over a communications link. The message bit sequence is 101011 (5 4 3 2 1 0). An FCS generator pattern of 1001 is used to generate the FCS sequence.

   a) How many FCS bits are generated? What are they? What is the transmitted bit sequence? Identify the FCS bits in that sequence. Show details of your work.

   b) Now suppose the received sequence is 010011001. Did errors occur? Will the receiver detect the errors? Prove your answer

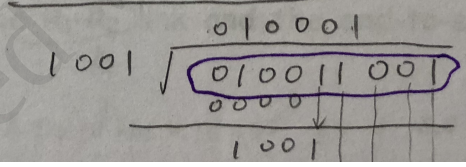
   c) Now suppose the channel introduces the following error pattern 010010111. Will the receiver be able to detect the error? Prove your answer analytically.

generator pattern = 1001 (4 bits)

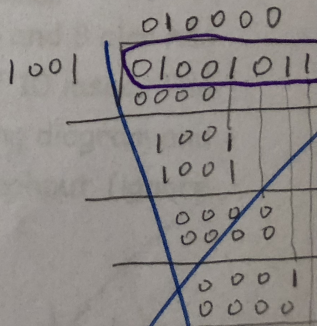


(b) T = 101011 110
R = 010011 001

Yes, errors occur

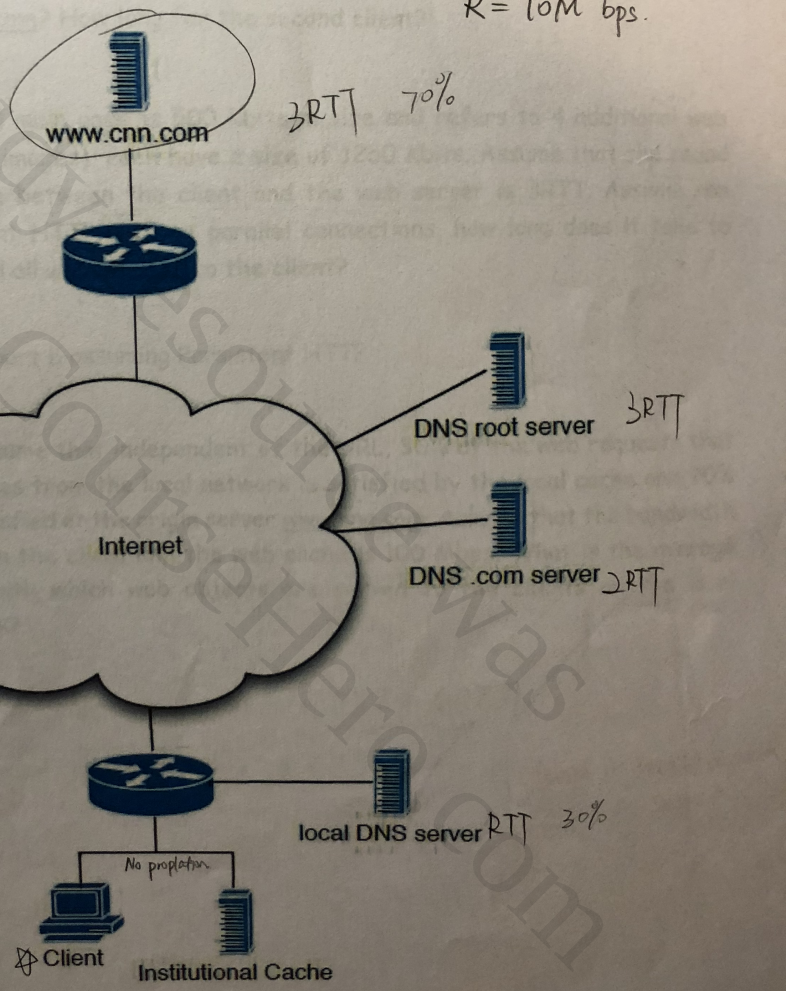


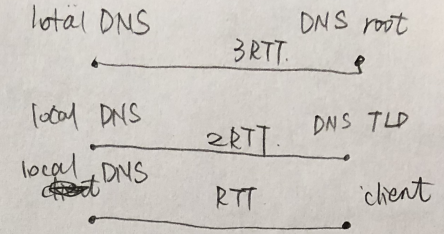
(c)



5. Consider the following scenario. Initially, assume that the client wants to retrieve the www.cnn.com home page but has no information about the www.cnn.comweb server IP address. Assume all links have 10Mbpscapacity and we assume there is no queuing delay at the routers, and the packet processing delays at routers and nodes are all 0. After the first client, a second client (connected to the same network as the first client) also wants to obtain the IP address of the www.cnn.com server.

R = 10M bps.





a. Assume that the round trip time between the Local DNS server and the DNS root name server is 3RTT, between the local DNS server and the DNS TLD server is 2RTT and between the clients and the local DNS server is RTT. How long does it take for the first client to get the IP address of www.cnn.com? How long for the second client?

b. The CNN main page is 500 Kbits in size and refers to 4 additional web objects (images), each have a size of 1250 Kbits. Assume that the round trip time between the client and the web server is 3RTT. Assume non persistent HTTP with no parallel connections, how long does it take to download all web objects to the client?

c. Repeat part b assuming Persistent HTTP

d. Now assume that independent of the URL, 30% of the web requests that originates from the local network is satisfied by the local cache and 70% are satisfied at the origin server www.cnn.com. Assume that the bandwidth between the client and the web cache is 100 Mbps. What is the average delay with which web objects are served to the clients on the local network?

R =

request →
reply.

First client takes 5RTT + RTT = 6RTT

Second client takes RTT

Cached in local domain Server