CS3205 - Introduction to Computer Networks

End Semester Examination - Jan-May 2020

PART-A

1) a) False

b) False

2)

Forwarding	Routing
→ Forwarding refer to routers local action of transfering an input packet to to next router in its path	→ Routing refer to network wide process of determining the path taken by a packet from source to destination
→ Every router has forwarding table that helps in determining the outgoing link of a specific packet	→ Routing algorithms determines the values to be inserted in a router's forwarding table.

3) In switch fabric if transfer speed is not so fast packet queuing can occur at input ports. In that case if two packets at front of at the front of 2 input queues have same output queue then one of these input queues must be halted. (switching fabric can transfer only one packet to a given output port at a time). All the packets in the halted queue are blocked eventhough they have free output port because of the queue head. This is head of the line (HOL) blocking and it occurs in input port.

4) Yes. In Dynamic Host Configuration Protocol (DHCP) we can see a valid IP packet with source address 0.0.0.0. During DHCP server discovery a newly arriving host without any IP address assigned, broadcasts DHCP discover/request messages with source IP = 0.0.0.0.

5) Checksum - one's complement of sum of 16 bit partitions of UDP segment

$\Rightarrow$ $(16 \times 0xF0F0)^c$

$\Rightarrow$ $(16 \times 0b\,1111\,0000\,1111\,0000)^c$

$\Rightarrow$ $(1111\,\underbrace{0000\,1111\,0000\,0000}_{16\text{ bits}})^c$

$\Rightarrow$ $(0000\,1111\,0000\,1111)^c$

$\Rightarrow$ $1111\,0000\,1111\,0000$

$\Rightarrow$ 61680 or 0xf0f0

6) Ethertype values of protocols

IPv4	-	2048 (0x0800)
Virtual LAN	-	33024 (0x8100) - C-Tag
		34984 (0x88A8) - S-Tag
		35061 (0x88F5) - MVRP
IPV6	-	34525 (0x86DD)
ARP	-	2054 (0x0806)

7) whatsapp - Extensible Messaging and Presence

protocol (XMPP), voice over Internet protocol (VoIP), IP, TCP etc

Thunderbird - Internet Message Access Protocol (IMAP)

Google Chrome - Hyper Text Transfer Protocol (HTTP), HTTPS

Git - HTTP, Git protocol

8) i) As long as Bob is connected to internet and have user agent access he can host the mail server

ii) Simple Mail transfer Protocol (SMTP) : port No. 25
: used for exchanging emails between servers
post office Protocol (POP3) : Port No. 110
used for exchanging emails b/w servers and user agents

9) Four components of delay are

i) processing - checking bit errors and determining output link
- variable, α packet length

ii) queueing - waiting for transmission
- Variable - for example if 5 packets arrive at an empty queue, first packet suffer no queueing delay but later

ones suffer more and more of it

iii) transmission - packet length / Bandwidth
- variable, $\propto$ packet length

iv) propgation - length of medium / propgation speed in medium
- fixed

PART- B

1) For UDP and IP the over head is 8 bytes UDP + 20 bytes IP per segment. Total over head is $(120{,}000/200) \times 28 = 16800$ bytes and % over head is $(28/228) \times 100 = 12.281\%$.

For TCP and IP, over head is 20 bytes TCP + 20 bytes IP per segment. Total overhead is $(120{,}000/200) \times 40 = 24000$ bytes, % overhead is $(40/240) \times 100 = 16.667\%$.

2) classful Addressing :

An IP address allocation method that allocates addresses into 5 major classes. A, B, C, D, E.

Examples: Roll No. - CS17B005, using 5 as last byte

A - 10.1.1.5 (1-126)

B - 172.16.1.5 (128-191)

C - 192.168.1.5 (192-223)

D - 230.2.2.5 (224 - 239)

E - 245.2.2.5 (240 - 255)

Classless Addressing:

Also called Classless InterDomain Routing (CIDR) is a more efficient way of allocating blocks of addresses upon demand, concerning certain rules.

Example: 192.1.2.0 - 192.1.2.31 is a valid block and 192.1.2.5 is a valid classless adress in that block

3) a) Queueing delay for first packet is 0, 2nd one is ttrans, 3rd one is 2×ttrans and so on.

$t_{rans} = L/R$

$$\text{Avg. Queueing delay} = \frac{1}{N}\left(\sum_{i=1}^{N-1} i(L/R)\right)$$

$$= \frac{L}{RN}\sum_{i=1}^{N-1} i = \frac{L}{RN} \times \frac{N \times (N-1)}{2} = (N-1) \times \frac{L}{2R}$$

b) If N packets arrive to link every LN/R seconds then by the time second set of packets arrived all the packets of first set are sent. So queueing delay is independant and same to each set of packets i.e. the average queueing delay stays the same - $(N-1)\frac{L}{2R}$

4) a) P_A - probababiliy of success of A in a slot

$= P(1-P)^3$ - A should transmit, BCD shouldn't

prob. of first success in 5th slot is

$= (1-P_A)^4 P_A = (1-P(1-P)^3)^4 \cdot (P(1-P)^3)$

b) prob. of success of each node is exclusive

and $P_A = P_B = P_C = P_D = P(1-P)^3$

hence either one succeeds is $4P(1-P)^3$

c) No success in first 2 slots and any one succeeds in 3rd slot

$(1-4P(1-P)^3)^2 \cdot (4P(1-P)^3)$

D) Efficienle of the system is = prob. of success in a slot $= 4P(1-P)^3$

5) a) i) GBN is better than SR

- Cumulative acknowledgements possible
- No requirement of buffer
- timer for oldest un acked packet is sufficient

ii) SR is better than GBN

- out of order acks possible
- more efficient w.r.t resources & time

b)

Flow control	Congestion control
→ Controlled by recieving side to ensure that sender only sends that reciever can handle	→ It is a method of ensuring every one has fair access to the resources
→ Local phenomenon	→ Global phenomenon
→ Monitered by sender	→ Initiated by routers

6) * $t_{trans} = L/R$ * $t_{prop} = d/s$

a) $t_{trans} = 1500 \times 8 / 10^9 = 0.000012 = 12 \times 10^{-6}$

$t_{prop} = 2200 \times 10^3 / 2.5 \times 10^8 = 88 \times 10^{-4}$

$RTT = 2 \times t_{prop} = 176 \times 10^{-4}$

$$\text{utilization} = \frac{N(t_{trans})}{RTT + t_{trans}}$$

$$* \; N = \frac{U(RTT + t_{trans})}{(t_{trans})}$$

$$N_{92\%} = \frac{0.92 \times 176.12 \times 10^{-4}}{12 \times 10^{-6}} = 1350.25$$

~ 1351

$$N_{98\%} = \frac{0.98 \times 176.12 \times 10^{-4}}{12 \times 10^{-6}} = 1438.31$$

~ 1439

b) $t_{trans} = 8 \times 9000 / 10^9 = 72 \times 10^{-6}$

$RTT = 176 \times 10^{-4}$

$$N_{92\%} = \frac{0.92 \times 176.72 \times 10^{-4}}{72 \times 10^{-6}} = 225.80$$
$$\sim 226$$

$$N_{98\%} = \frac{0.98 \times 176.72 \times 10^{-4}}{72 \times 10^{-6}} = 240.53$$
$$\sim 241$$

PART-C

1) a) i) Data Link Layer
ii) MSS - Maximum Segment Size

b) The transport layer when such a huge file transfer is required, breaks into segments of size less than or equal to MSS. Each segment is implicitly assigned a sequence no. The best way to send the data is to break the file into segments of MSS bytes and send in ⌈100k/MSS⌉ transfers. On the otherhand one can send just 1 byte in a TCP segment and make 100k transfers. Everything in between is a possible way to send too.

c) Each layer has its theoritical limits of data it can send. From wireshark capture we can get the size of data. Comparing these sizes with the limits we can figure out which layers involved in restriction.

2) a) Physical layer -
Data Link layer - MAC - 88:B1:11:F5:87:D2

Network layer - IPv4 - 192.168.29.71

Transport layer - Port No. - 22

Application layer -

b) MAC - 48 bit

IPv4 - 32 bit

Port No. - 16 bit

c) Network layer indentifier changes to IPv6 - 128 bit, rest remains same

3) a) Address Resolution protocol (ARP)

b) a) ARP request message

Sender IP - 192.168.1.4

Sender MAC - 64:5d:86:7c:78:74

Target IP - 192.168.1.1

Target MAC - 1c:5f:2b:2d:16:00

Requesting for MAC of 192.168.1.1

b) ARP reply message

Sender IP - 192.168.1.1

Sender MAC - 1c:5f:2b:2d:16:00

Target IP - 192.168.1.4

Target MAC - 64:5d:86:7C:78:74

Replying for the above with Sender MAC

c) Broadcast ARP request

Sender IP - 192.168.1.4

Sender MAC - 64:5d:86:7c:78:74

Target IP - 192.168.1.5

Target MAC - 00:00:00:00:00:00

Broadcasting request for MAC Address of

D) ARP Reply message

Sender IP - 192.168.1.5

Sender MAC - 88:b4:a6:28:76:16

Target IP - 192.168.1.4

Target MAC - 64:5d:86:7C:78:74

This is replying with its MAC

4) The protocol is udp and IP. It is a standard DNS query packet.

Source socket - 192.168.1.4/57071 (IPv4/Port)

Source MAC - 64:5d:86:7C:78:74

Dest. Socket - 218.248.112.99/53

Dest. MAC - 1c:5f:2b:2d:16:00

No. of queries - 1

Name - www.stanford.edu

Host Address - Type A

Class - IN

The packet intends to request IP address of this website from DNS server

PART-D

2) a) Data link layer - It does framing of bits, adding MAC addresses at the start, Error control, Flow control, Access control etc

b) The method used here is 2 dimensional bit parity. It can detect and correct single bit errors

1	1	0	0	✓	even set bits - 0
1	1	1	0	×	odd set bits - 1

1	1	1	1	✓
1	$\boxed{0}$	0	1	
✓	α	✓		

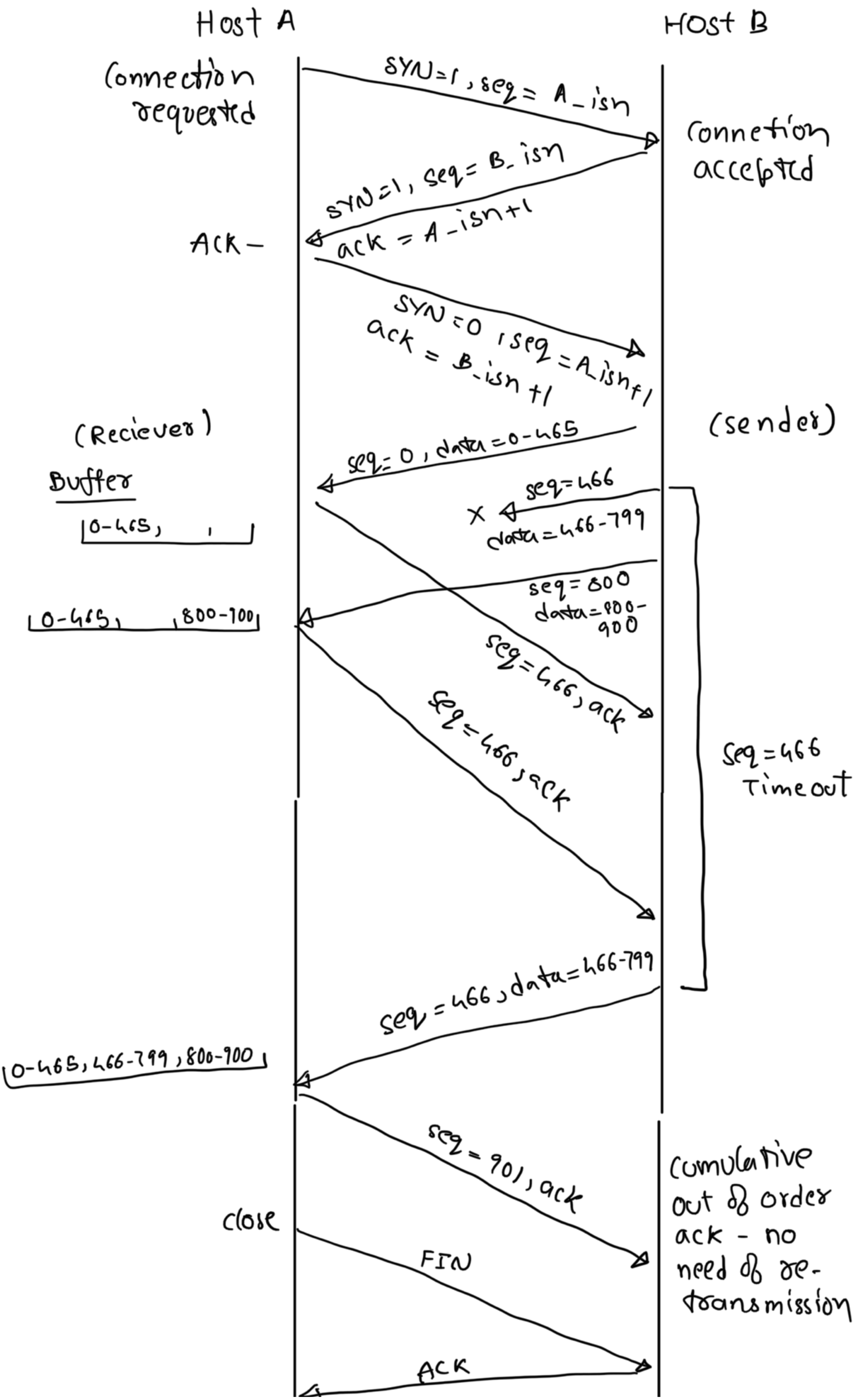
Yes there is an error in the center bit and it's correctable. we just need to flip it the corrected data is 1100, 1010, 1111, 1001

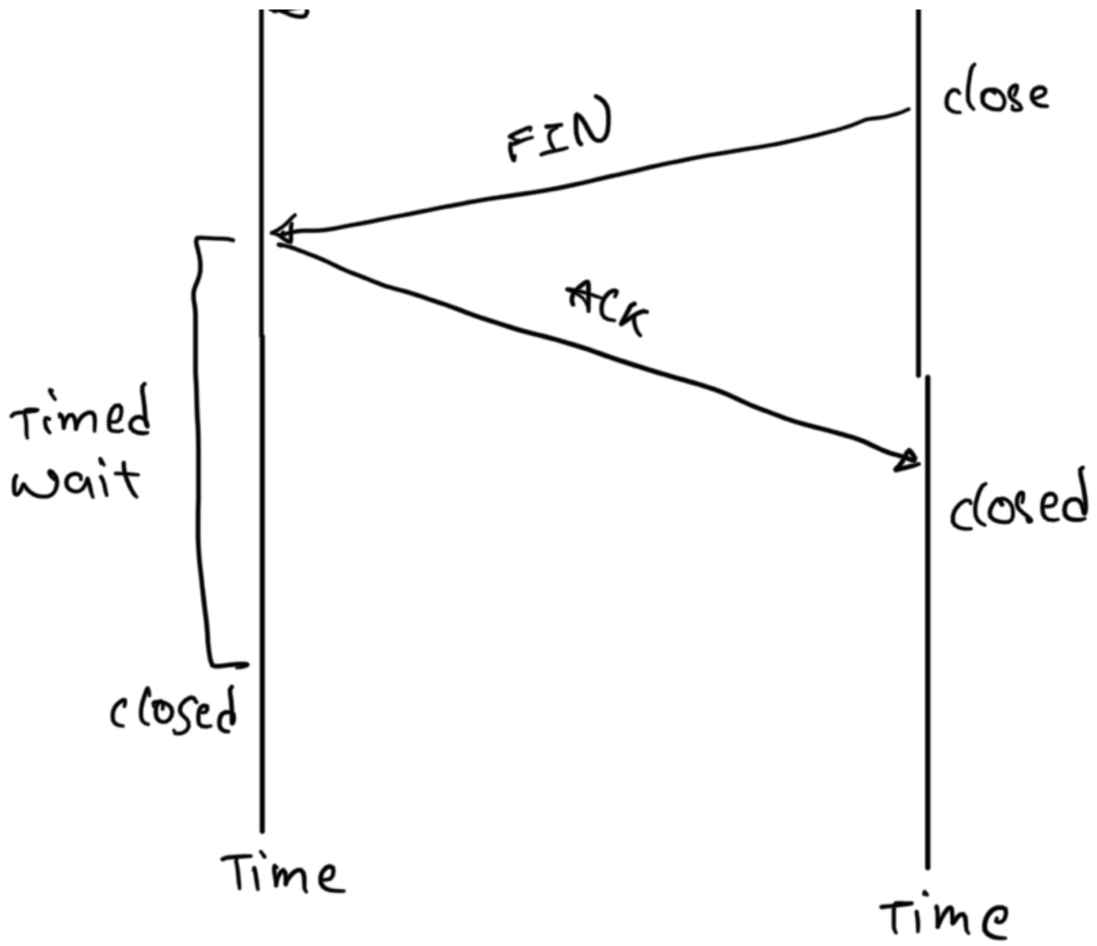
c) D+R - 101010101 , G - 1001

$$
\begin{array}{l}
1001 \sqrt{101010101} \\
\quad 1001 \\
\hline
\quad 001110101 \\
\qquad 1001 \\
\hline
\qquad 0111101 \\
\qquad\; 1001 \\
\hline
\qquad\; 011001 \\
\qquad\;\; 1001 \\
\hline
\qquad\;\; 01011 \\
\qquad\;\;\; 1001 \\
\hline
\qquad\;\;\; 0010
\end{array}
$$

the xor division of D+R and G should give zero as its not zeror hence ther is an error in the recieved packet.

3) TCP connection





5) For client server distribution the min. distribution time is max of upload time for server or man download time of client

$$Dcs = max(N \times F/Us, F/dmin)$$

For peer to peer distribution download time remains same but server needs to upload just once and total upload is handled using all resources.

$$Dp2p = max(F/Us, F/dmin, NF/(Us + \Sigma Ui))$$

client server	10	100	1000
500 kbps	6400	51200	512000
1 Mbps	6400	51200	512000
2 Mbps	6400	51200	512000
peer to peer			
500kbps	6400	25904	47559
1Mbps	6400	17067	29381

2Mbps 6400 10240 12488

1) a) Code Division Multiple Access (CDMA)

Limitations: Signal attenuation causes problems

b) By assigning a code to me and 7 other students using a Walsh table of size 8x8 (W_8)

c) $W_1 = [1]$

$W_2 = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$

$W_4 = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$

$W_8 = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 & 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 & 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 & 1 & -1 & -1 & 1 \\ 1 & 1 & 1 & 1 & -1 & -1 & -1 & -1 \\ 1 & -1 & 1 & -1 & -1 & 1 & -1 & 1 \\ 1 & 1 & -1 & -1 & -1 & -1 & 1 & 1 \\ 1 & -1 & -1 & 1 & -1 & 1 & 1 & -1 \end{bmatrix}$

$W_{2N} = \begin{bmatrix} W_N & W_N \\ W_N & \overline{W_N} \end{bmatrix}$

Roll No. CS17B005 - 1 2 3 4 5 6 7 8 - Instances

$F_0 = 5 \Rightarrow$ 0 0 0 0 0 1 0 1

$F_1 = 105 \Rightarrow$ 0 1 1 0 1 0 0 1

$F_2 = 205 \Rightarrow$ 1 1 0 0 1 1 0 1

$F_3 = 50 \Rightarrow$ 0 0 1 1 0 0 1 0

$F_4 = 150 \Rightarrow$ 1 0 0 1 0 1 1 0

$F_5 = 250 \Rightarrow$ 1 1 1 1 1 0 1 0

$F_6 = 95 \Rightarrow$ 0 1 0 1 1 1 1 1

$F_7 = 195 \Rightarrow \quad 1100\ 0011$

i) Result = scalar product of bits with corresponding rows from W_8 matrix

Instance 4 = $0 \cdot [1111\ 1111] +$

$0 \cdot [1\ 1\ -1\ -1\ 1\ 1\ -1\ -1] +$

$1 \cdot [1\ -1\ 1\ -1\ -1\ 1\ -1\ 1] +$

$0 \cdot [1\ -1\ -1\ 1\ 1\ -1\ 1\ 1\ -1]$

$= [1\ -1\ 1\ -1\ -1\ 1\ -1\ 1]$

Instance 7 = $0 + 0 + 1 \cdot [1\ -1\ 1\ -1\ -1\ 1\ -1\ 1]$

$1 \cdot [1\ -1\ -1\ 1\ -1\ 1\ 1\ -1]$

$= [2\ -2\ 0\ 0\ -2\ 2\ 0\ 0]$

ii) F_i data = Inner product of recieved vector and ith row of W

$F_2 = [1\ -1\ 1\ -1\ -1\ 1\ -1\ 1] \cdot [1\ 1\ -1\ -1\ 1\ 1\ -1\ -1]$

$= 1\ -1\ -1\ 1\ -1\ 1\ 1\ -1 = 0$ at instance 4

F_0 at instance 7 =

$[1111\ 1111] \cdot [2\ -2\ 0\ 0\ -2\ 2\ 0\ 0]$

$= 2 - 2 + 0 + 0 - 2 + 2 + 0 + 0 = 0$

Both are correct from prev. sub question

6) a) Starting point : 114.5.154/22

Subnet A : 114.5.154.0/25 - 114.5.155.0/29

B : 114.5.155/24

C : 114.5.154.128/25

D : 114.5.154.0/31

E : 114.5.154.2/31

F : 114.5.154.4/30

b) R1:

01110010	00000101	10011010	0 – A
01110010	00000101	00000000	0000000 – D
01110010	00000101	00000001	0000001 – F

R2 :

01110010	00000101	10011010	1 – C
01110010	00000101	10011010	0000001 – F
01110010	00000101	10011010	0000001 – E

R3:

01110010	00000101	10011011	– B
01110010	00000101	10011010	0000000 – D
01110010	00000101	10011010	0000001 – E

4) a) 4

b) src MAC is its own MAC address (A)
dst. MAC will be MAC of Gateway G1

c) Yes, It gets updated with the mac of next router in path or to the MAC of server B

d) src IP – 192.168.10.101
dst IP – 110.41.42.104
TTL = 30sec , flag = 0 , checksum = Some 16 bit
Protocol = UDP , Length = 100 bytes

e) TTL will change for every hop

f) Src port = 55 (Host A)

dst. port = 155 (server B)

Length = 36 bytes, checksum = some 16 bit

g) No, udp header contents will not change for every hop.