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(I) Application

HTTP/FTP/TFTP/TELNET
SMTP,

(II) Presentation

(III) Session

(IV) Transport

UDP, TCP

(V) Network layer

TID, ARP,

(V) Data

Error control, flow control, access control,

Error detection, Error correction, Others

VRC, LRC, CRC, Checksum, Hamming code.

Sliding window, S/W protocol

S.R, Go back N

Aloha, Pure aloh, Slotted aloha,

CSMA

CSMA, CSMA CD

(VI) Physical layer:-

Bit synchronization:-

encoding:-

mode of communication:-

signal transformation.

framing:-

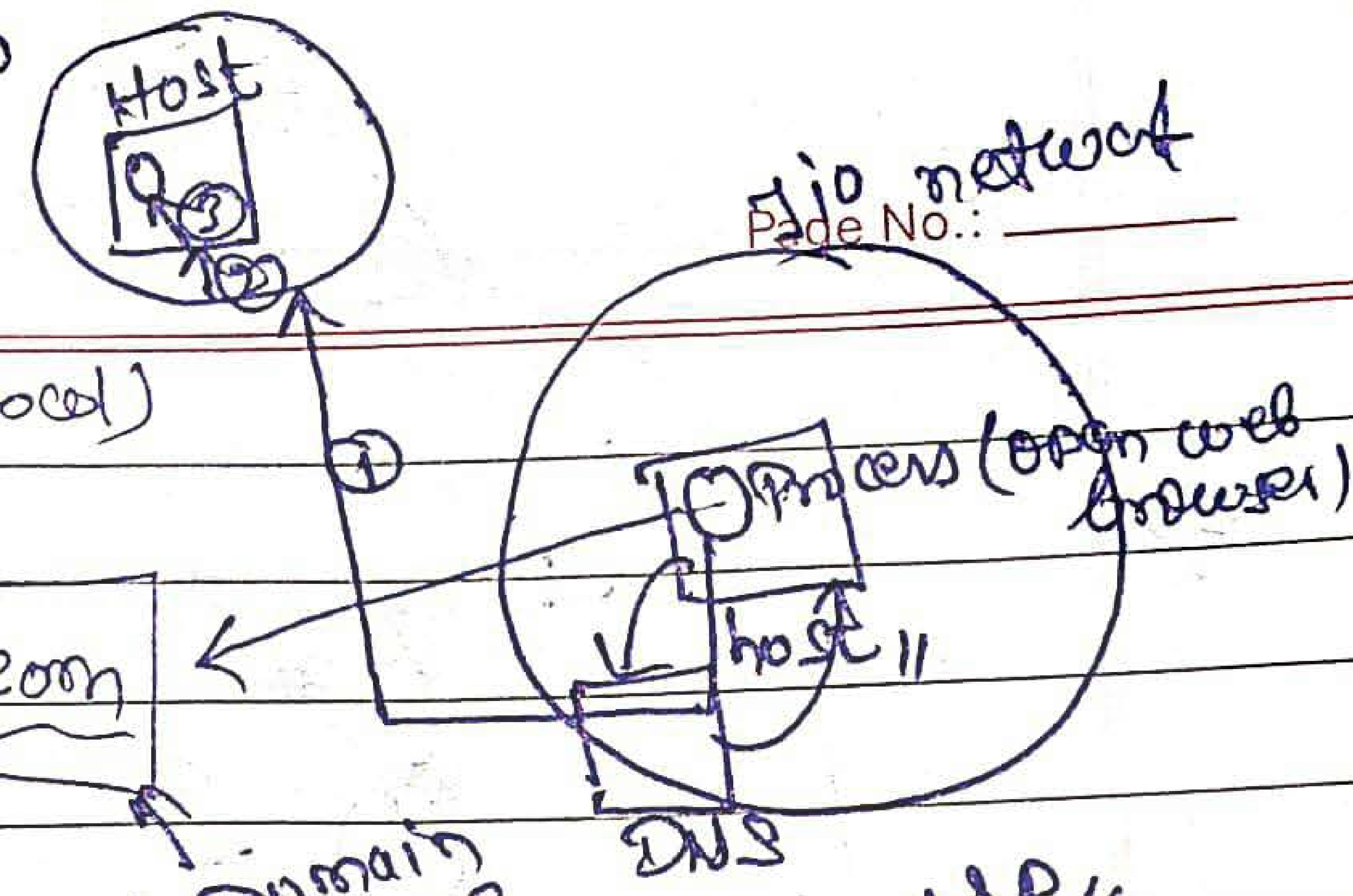
Page No.:

⇒ Network Security
- Private key/Public ke
- Symmetr/ non-symmet
- RSA, Fabbe
- modula

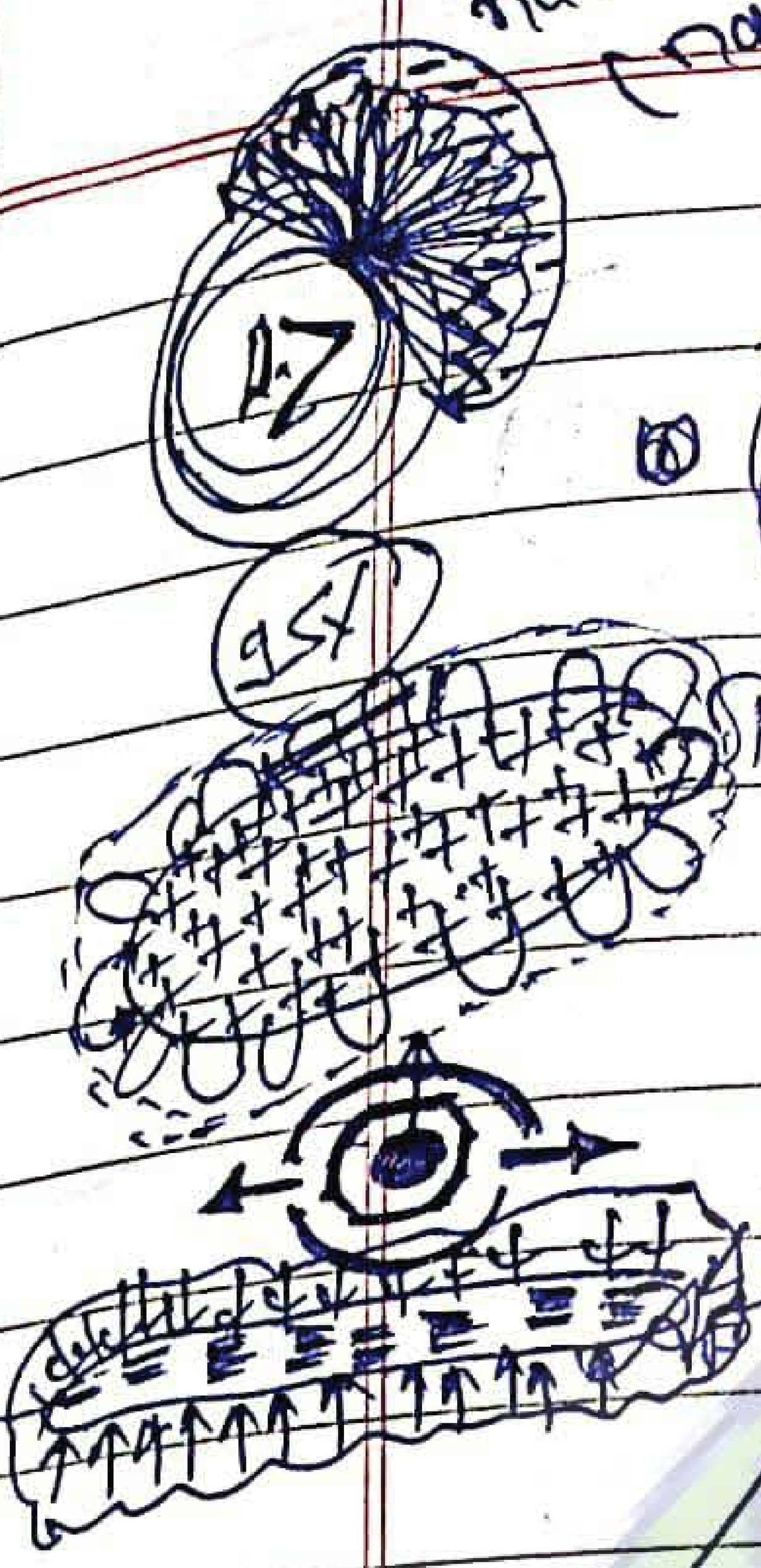
* What is network
  - Network means interconnection

" In information technology, a network is a series of points or nodes interconnected by communication path.

* DNS → Domain name system N/W
(name ↔ ip resolution)
UDP port no. 53



Page No.:



API (Application layer Protocol)

http://www.Amazon.com

Protocol → Request Protocol / Response Protocol

Domain name

I - Application Protocol Interface

Network id

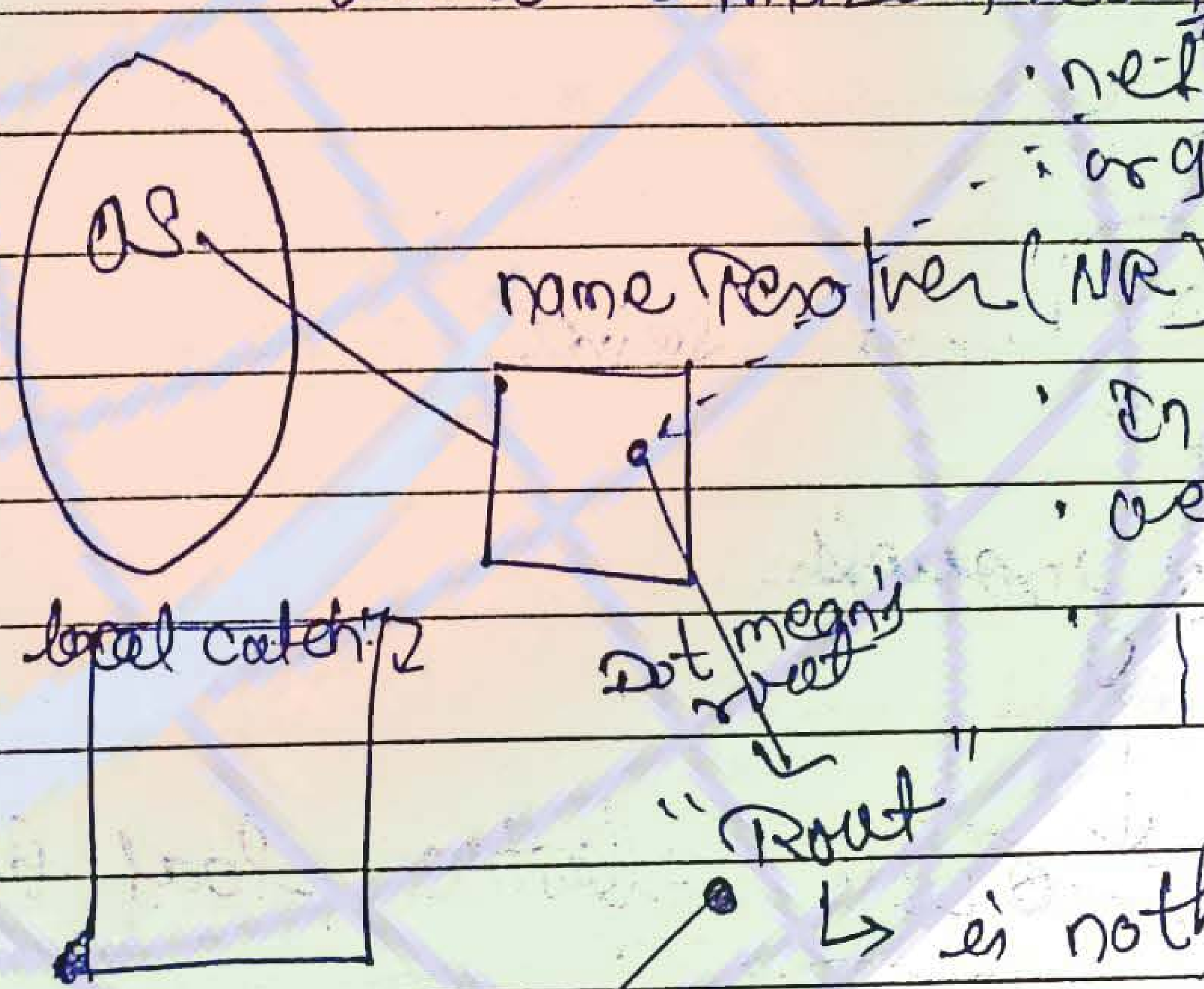
ip addr → host id

| N ID | H IP |

Port number (80)

Process number

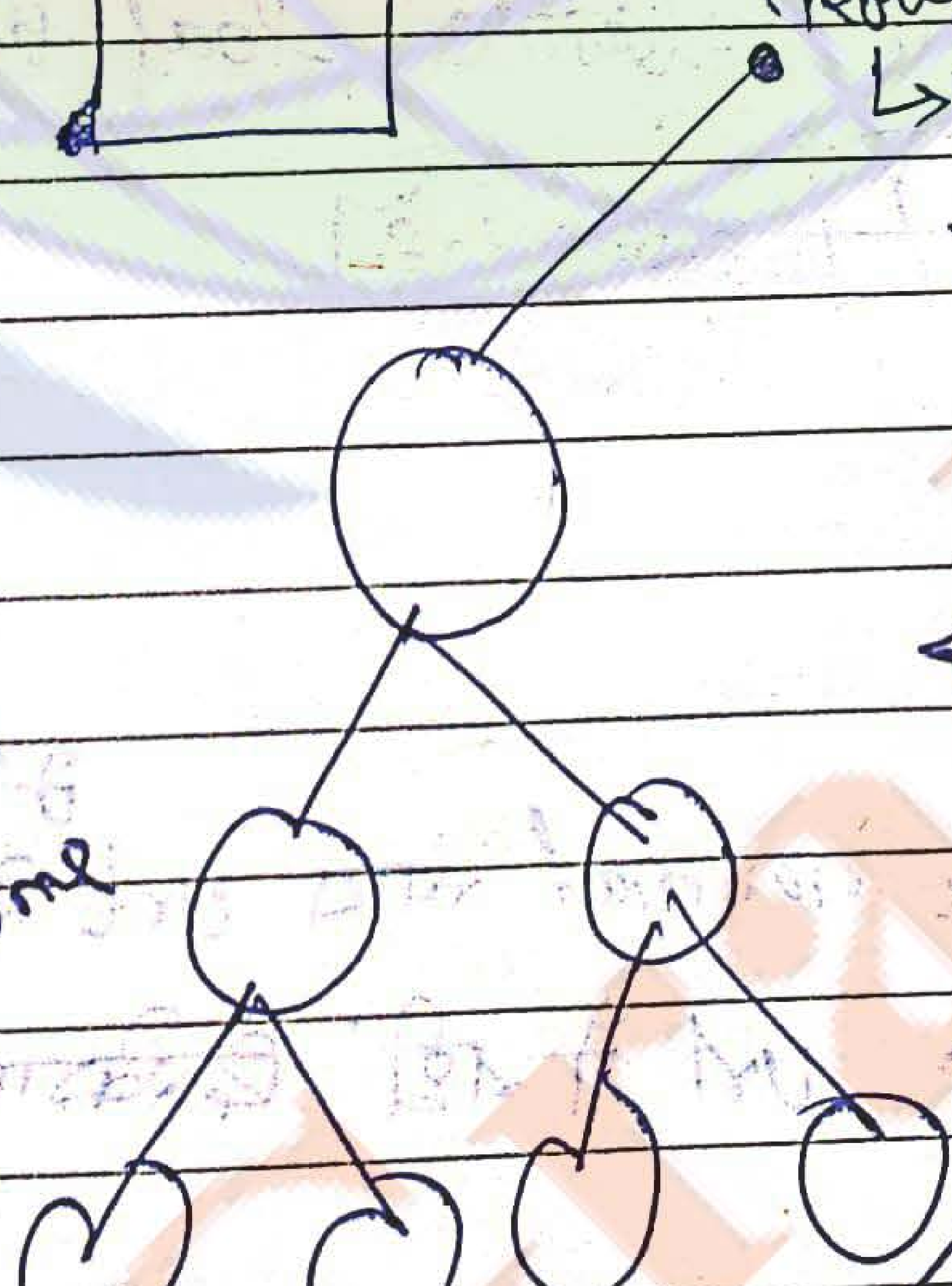
www.Amazon.com → String
.net
.org
.in
.website



"Root"
↳ is nothing but the Top level domain name Resolver.

hosts.txt file

www.google.com. — Domain name
↓ इस server का नाम web server है, इस पर website hosted है

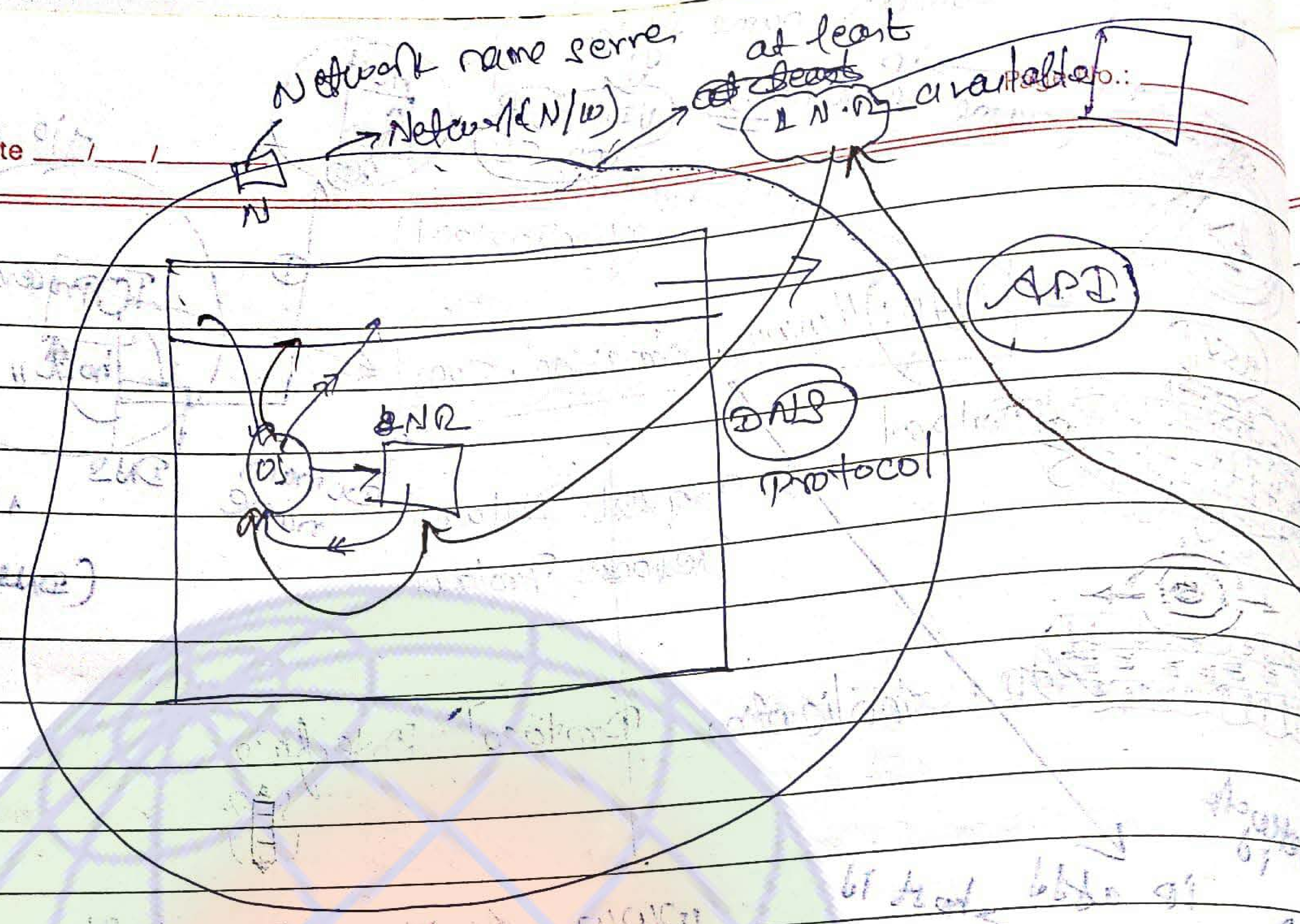


← Inverse tree structure

→ Resolving name server → Root name server → TLD name server → Authoritative name servers.

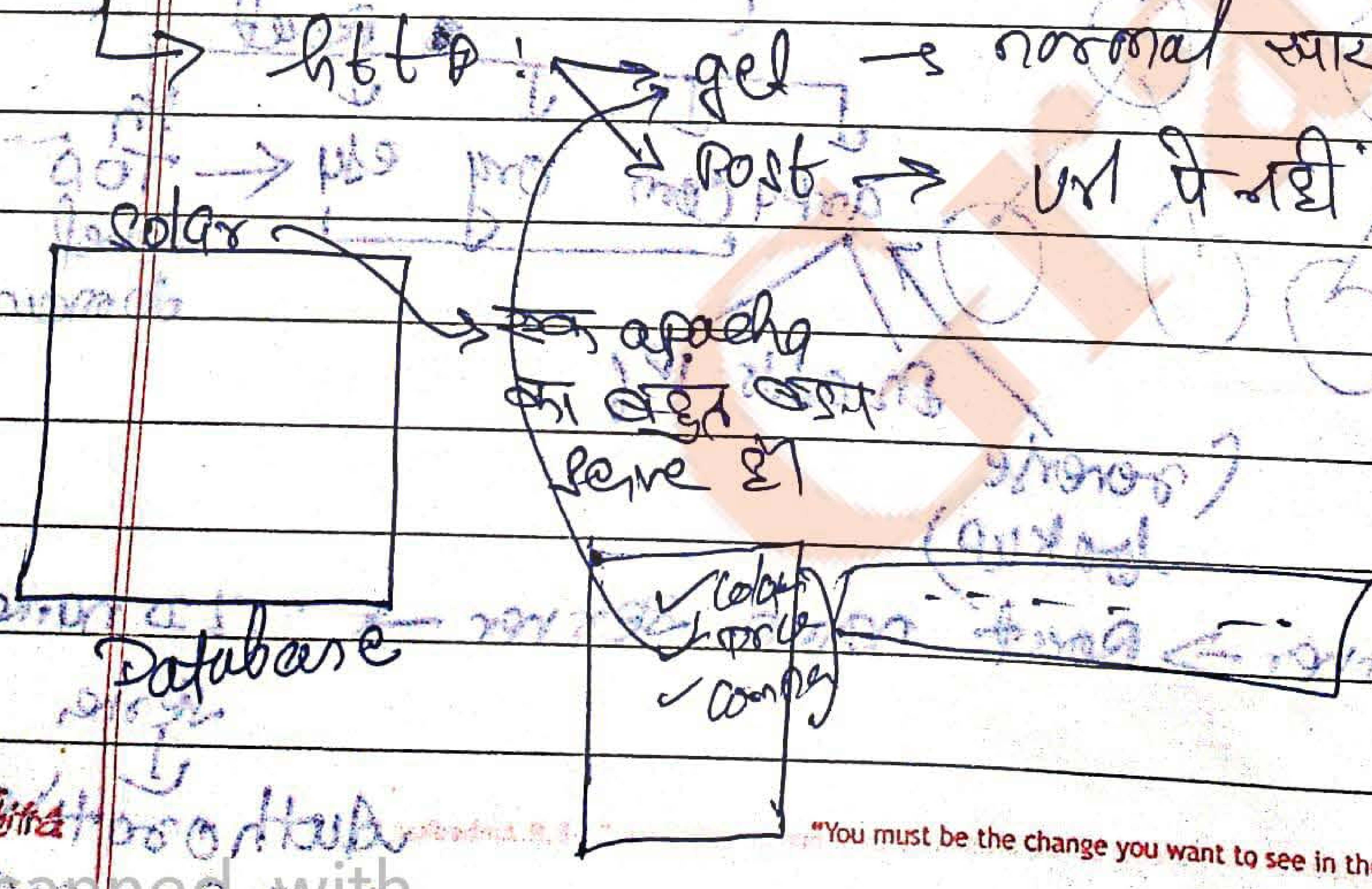
Date ___/___/___

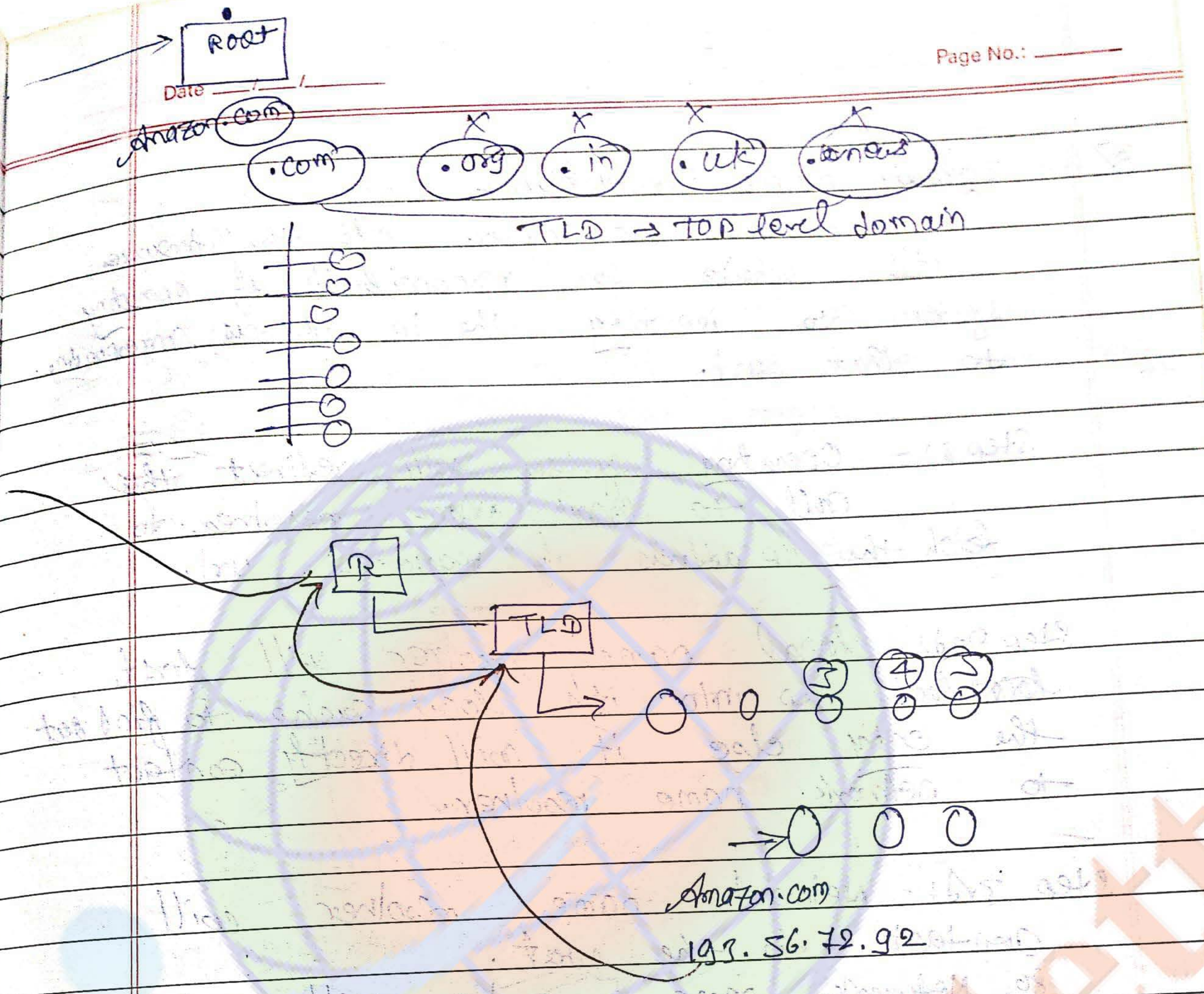
Q.7

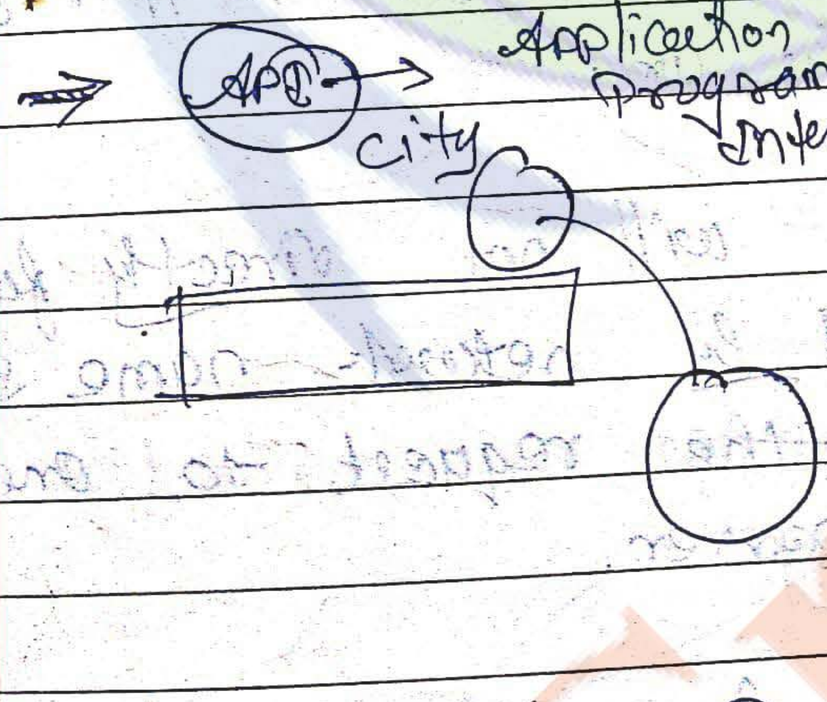


⇒ 384 root serve
↓
13 groups
↓
ELB elastic load balancer
→ server है

└→ http : → get → normal स्पाय url पे दिखता है
→ post → url पे नहीं दिखेगा |







Communication Problem :-

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37 Domain name Resolution:-
when we hit any url into the browser, it's whole sole responsibility of operating system to identify the ip address corresponding to that url.

Step 1:- Operating system will redirect this call to local name resolver to fetch the IP address of requested url.

Step 2nd:- local name resolver will first look up into its local cache to find out the entry else it will directly contact to network name resolver.

Step 3rd:- Network name resolver will contact to the next.
So, Network name resolver will contact one of all 13 root server to find out the ip address of the url.

Step 4th:- Root server will not directly fullfil the request raised by network name server it will re-direct the request to one of top level domain name server.

step 5th:- So Top level domain name server will re-direct this request to some set of local servers which contain information about that url.
It might be possible that multiple

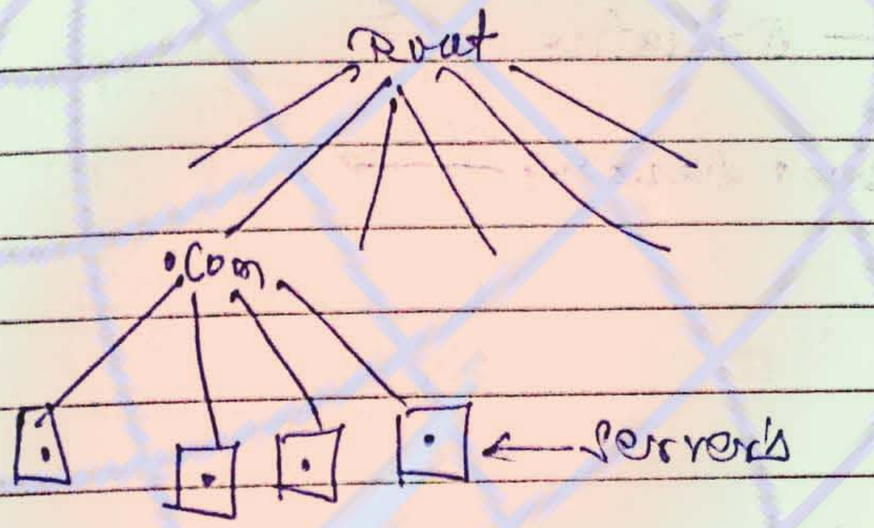
Date __/__/____

47 6th:
En
the

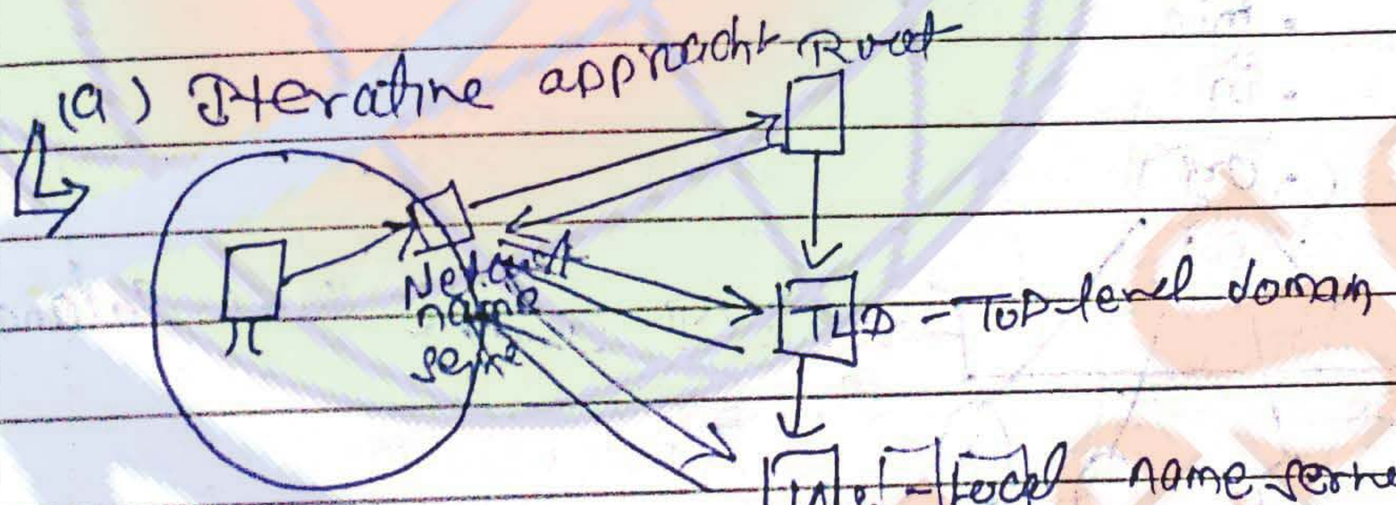
No.: _____ Date __/__/____ Page No.: _____

server can have the entry of requested url.

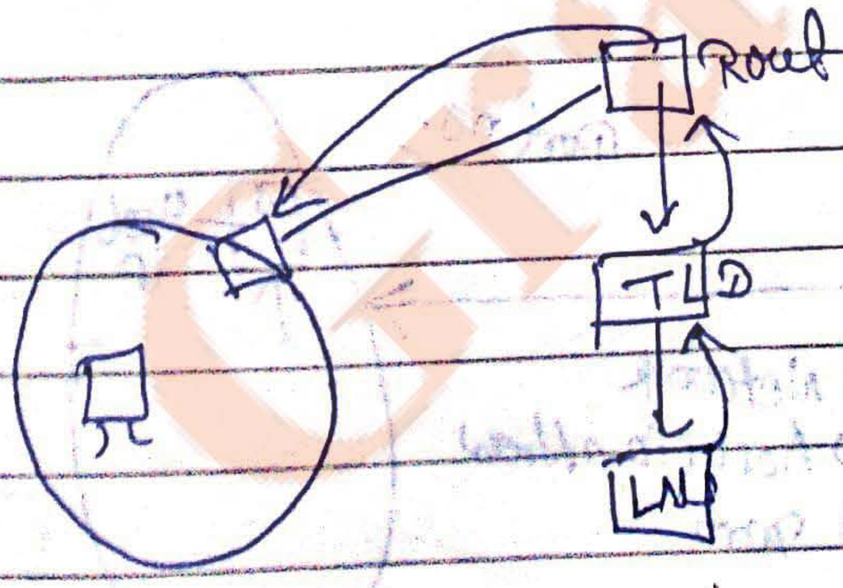
Ans 6th:-
In the above scenario, we can process the request in two ways:-
(a) Iterative
(b) Recursive



(a) Iterative approach



(b) Recursive approach



Citra

"Cultivation of mind should be the ultimate aim of human existence." —B.R.Ambedkar

Part 2

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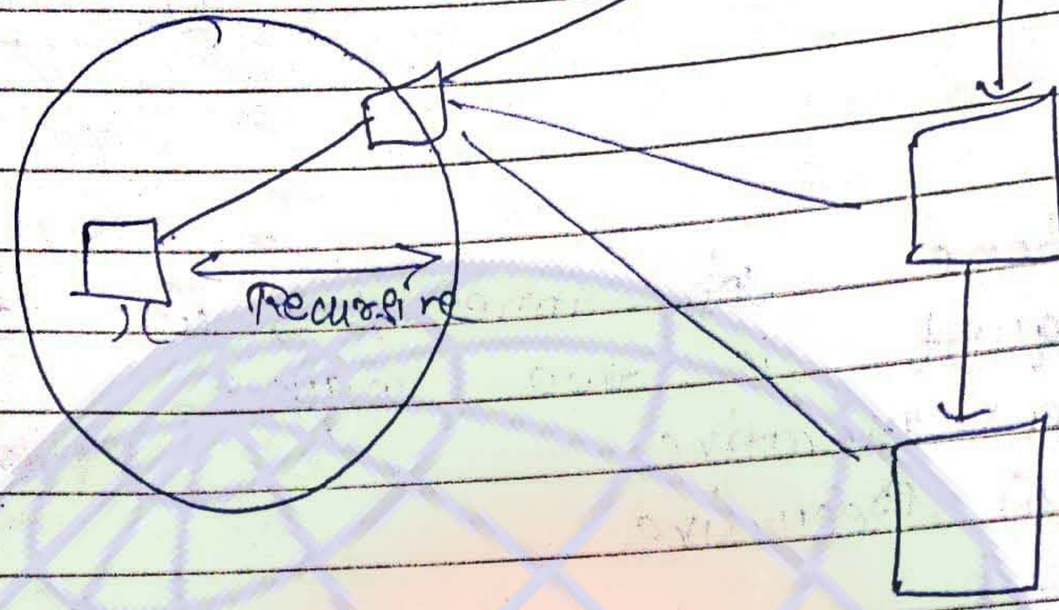
Note:

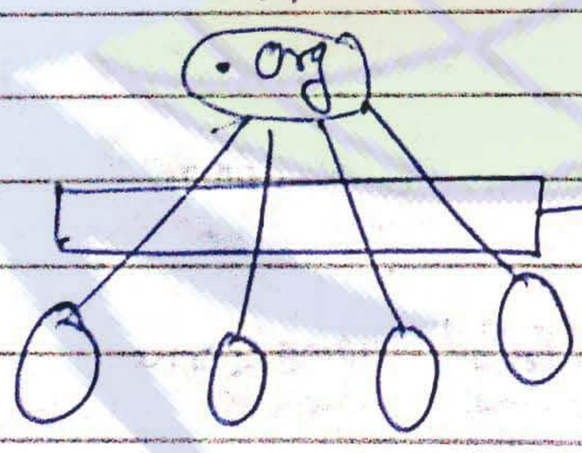


← Iterative →

← Recursive + Iterative →

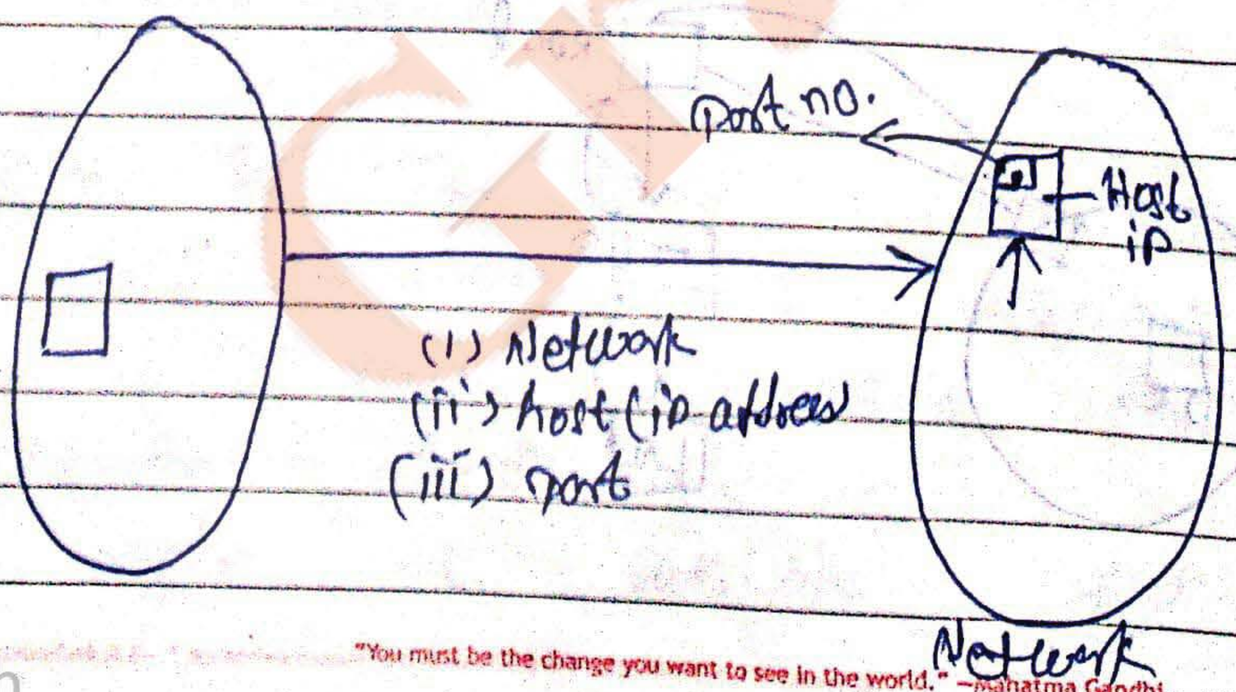
↳ Registry: -

- mic
- in



(elastic load balancer)

5) Communication Problem: -



पोर्ट -> more
↳ kaak mehnat
↳ k k kush/

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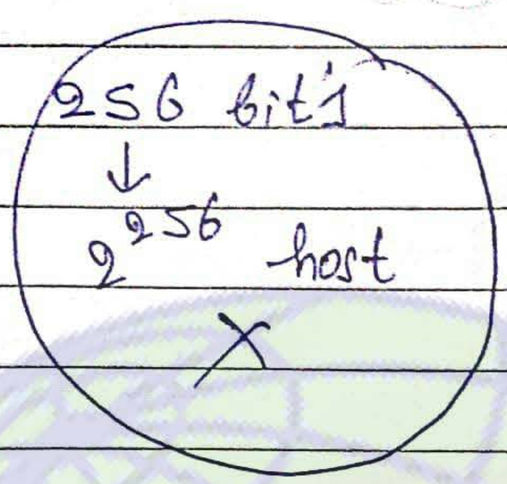
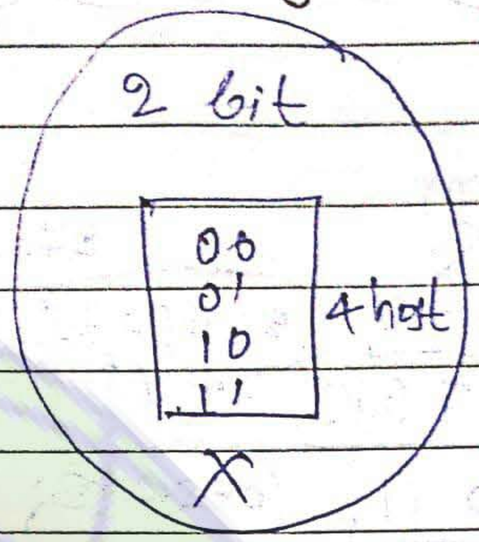
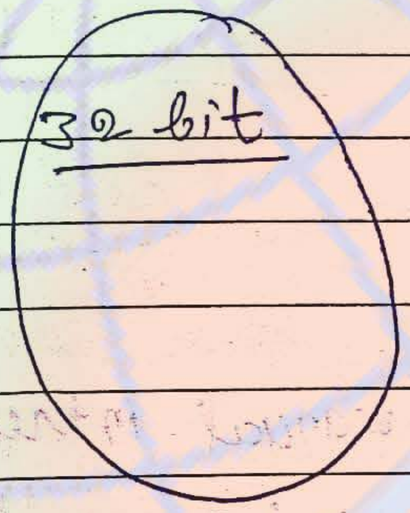
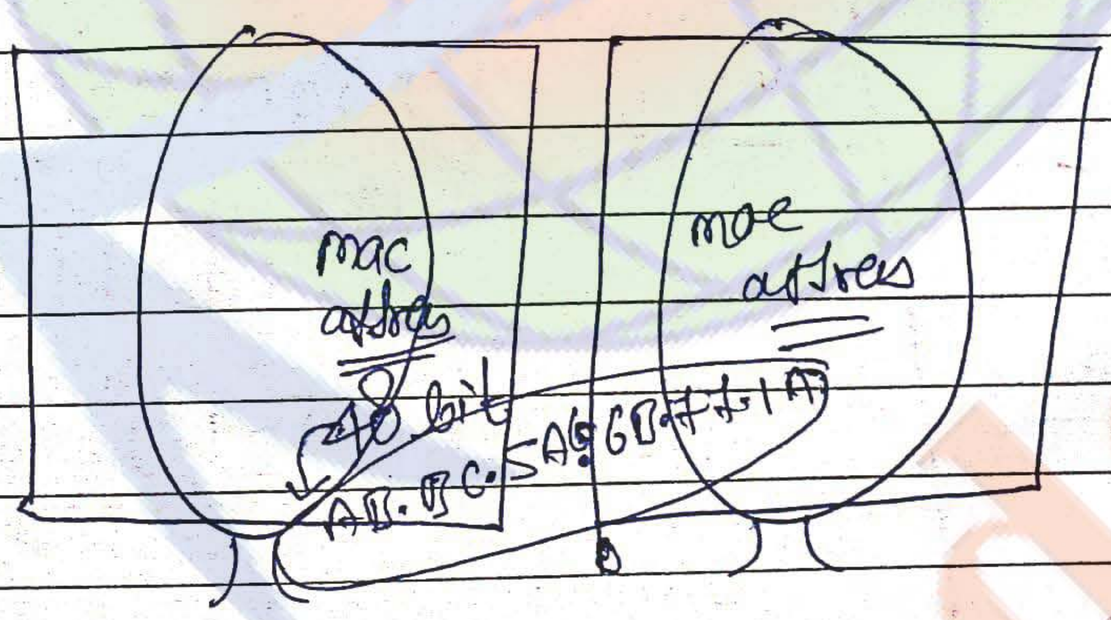
Q:1 ISO - Internal standard of organisation





128





If mac addres of diff compute is available then why we need ip addres

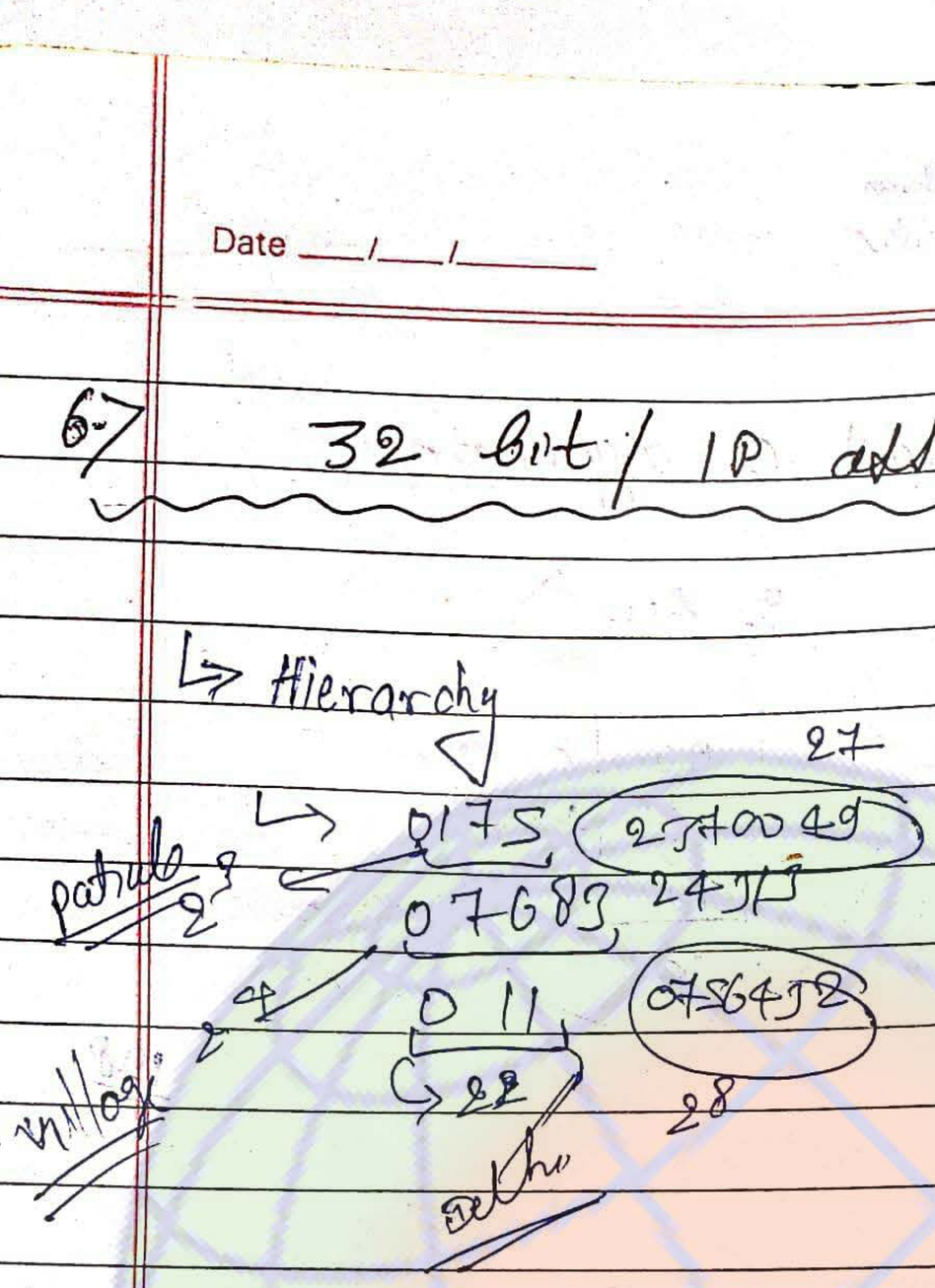
Reason: -> mac addres does not have any hierarchy, so we not use it for networking.

Date __/__/____

(1)

6.7 32 bit / IP address! -

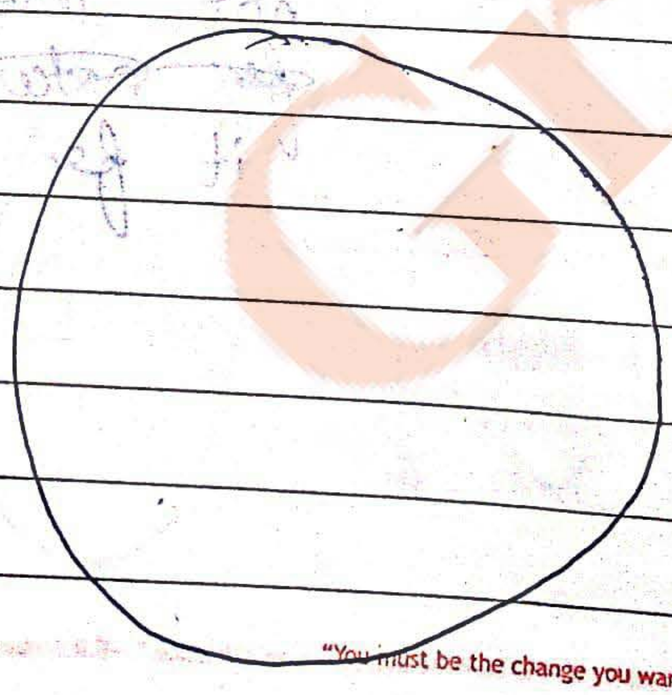
↳ Hierarchy

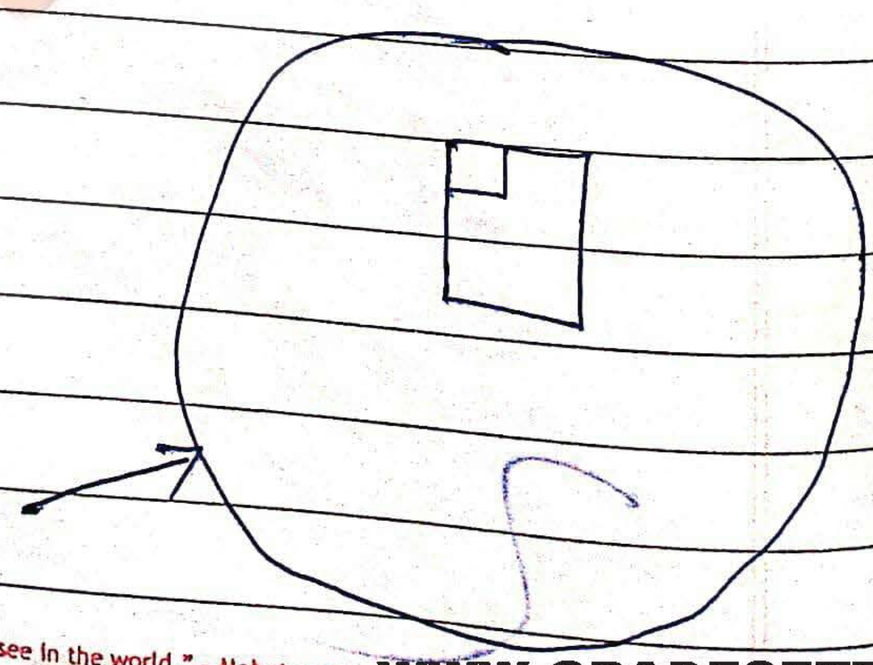


↳ Host - local pe, manual interupt is needed.
server - Auto responded, more well structured

7.7 IP - Address -

(i) class A
(ii) class B
(iii) class C
(iv) class D
(v) class E





Chitra

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(1) Class A :-

8 bits | 24 bits

Network id	Host id

2^8 | 2^{24}

2^{24}

00000000	0000 - - - - - - - - 00
11111111	1111 - - - - - - - - 11

These not be the part of network id.

0 - 255

x x

So,

Real id :

00000001

|

11111110

(1-254)

So,

host = $2^{24} - 2$

Note :-

0000000 1

|

Reserved

0 1111110

Also not allow to use

1 - 127

x

127.x.y.z x

So, Real is 1 - 126 ✓ Any

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0 0 0 0
0 0 0 1
0 0 1 0
0 0 1 1
0 1 0 0
0 1 0 1
0 1 1 0
0 1 1 1

$2^4 = \frac{16}{2} = 8$

↓

50%.

$\frac{2^{32}}{2} = 50\%.$

So, 50% Address is wastage in class A.

So,

Range of Class A = 1 to 126

↳ 000 00001 : 00000000 00000000 00000001

1111 - - - - - - - -

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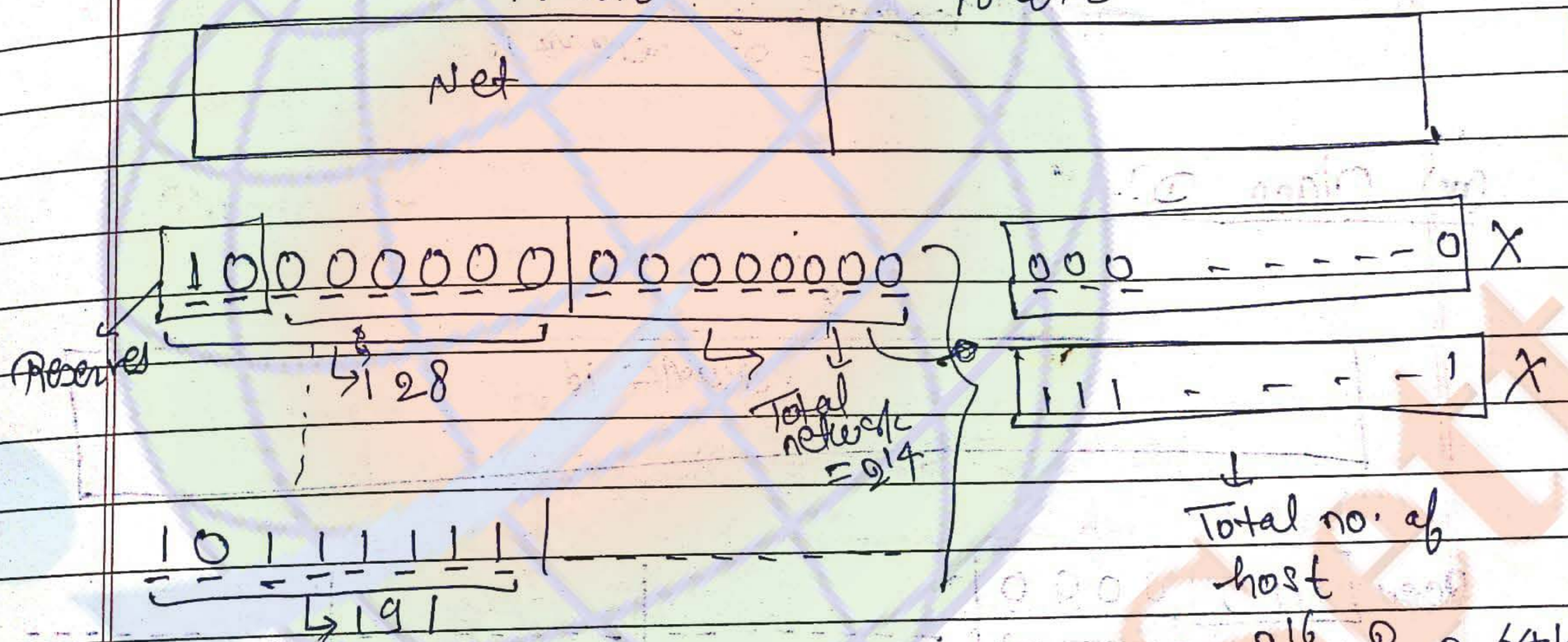
Notes:- Class का identification सबसे initial के 8-bit से ही होता है।

H.W

ipconfig:-

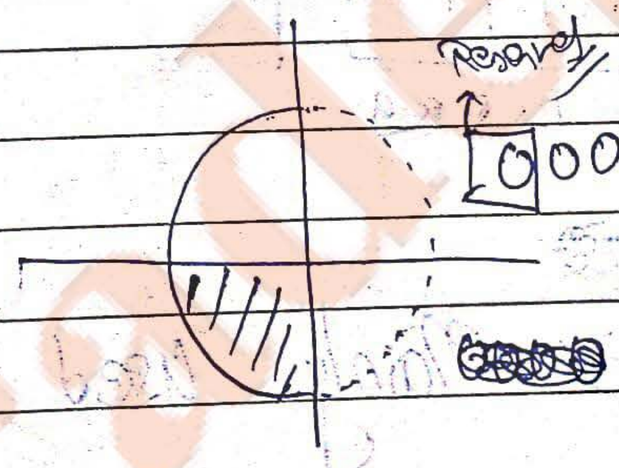
in linux laptop:-

(ii) class B:-



Range = 128 - 191

is used for the identification of class and the range is from 1st 8-bit only.



(iii) Class C:-

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Reserved 110 00000 | ---------- | ---------- | 00000000 X

↳ 192

110 11111 | | | 11111111 X

↳ 223

Total host = $2^8 - 2$ = 254

Range = 192 to 223

Reserved

$24 - 3 = 21$

Total network id = 2^{21} network id

(iv) Class D :-

$2^{?2}$

Network id

Reserved 1110 0000 | ---------- | ---------- | ----------

↳ 224

1110 1111 | | |

↳ 239

↳ Total no of Public ip's = 2^{28}

Reserved

↳ Mainly used for multicasting.

(v) Class E :-

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Reserved

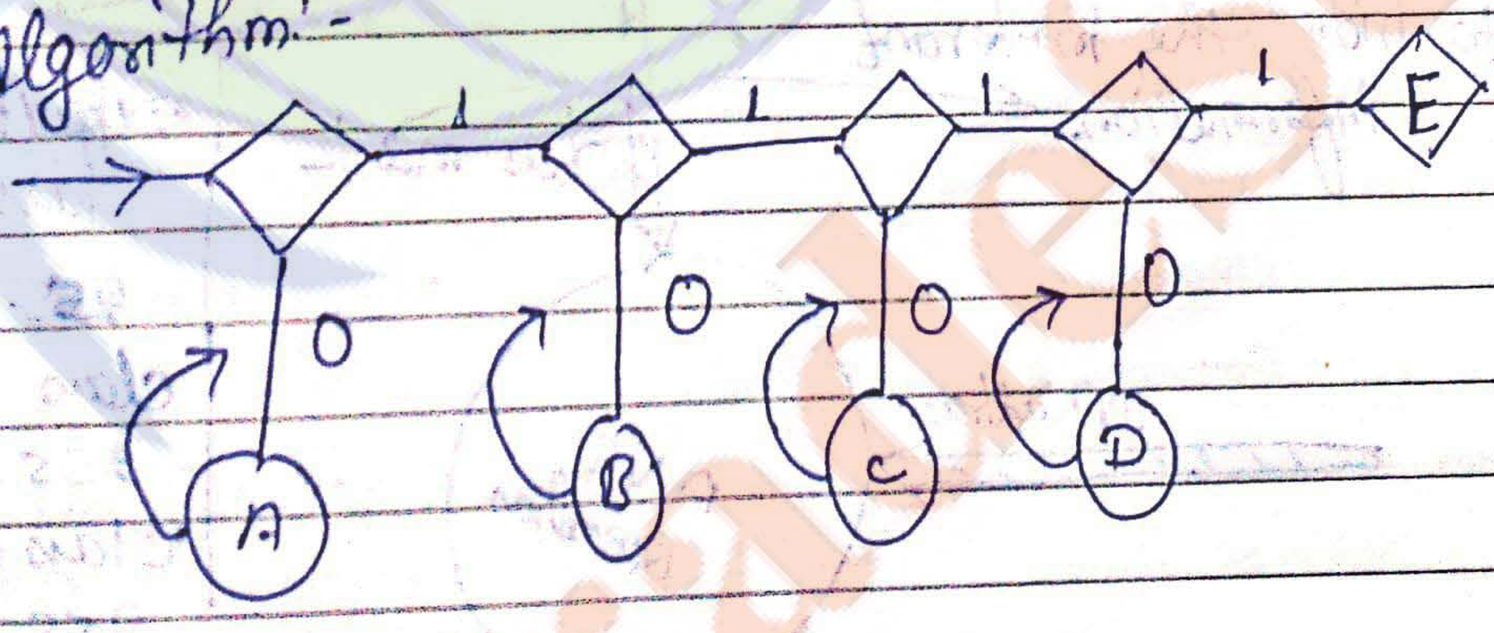
1111 0000

1111 1111

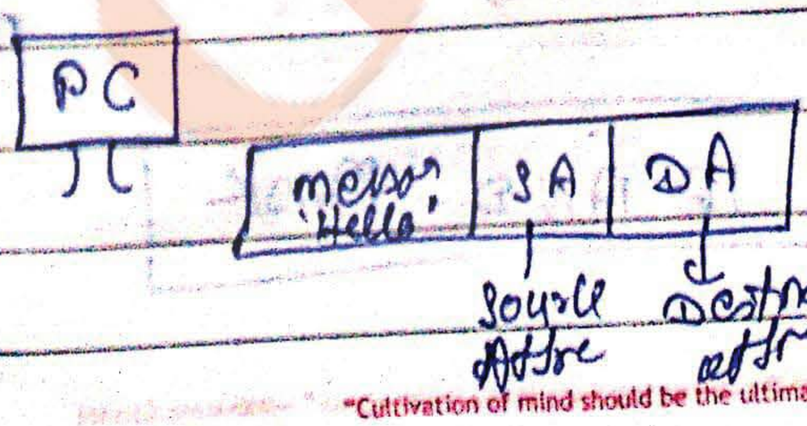
Range - 240 to 254

* Range:-
class A = 1-126
B = 128-191
C = 192-223
D = 224-239 - multicasting
E = 240-254 - Reserves for future

* Algorithm:-



* Object oriented Principle:- Abstraction



"Cultivation of mind should be the ultimate aim of human existence." –B.R.Ambedkar

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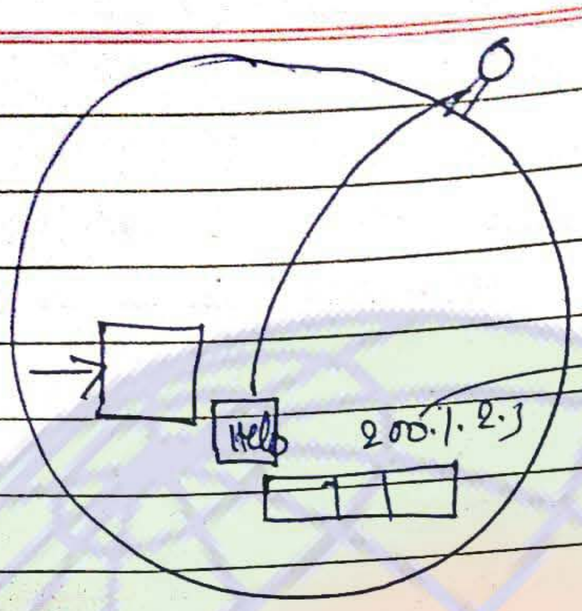


1100 1000 00000011

class C

255 255 255

255.255.255.0

default mask of A

Irrelevant operation को हटाने के लिए सभी zero को 1 कर दिया | ans follow "AND" operation

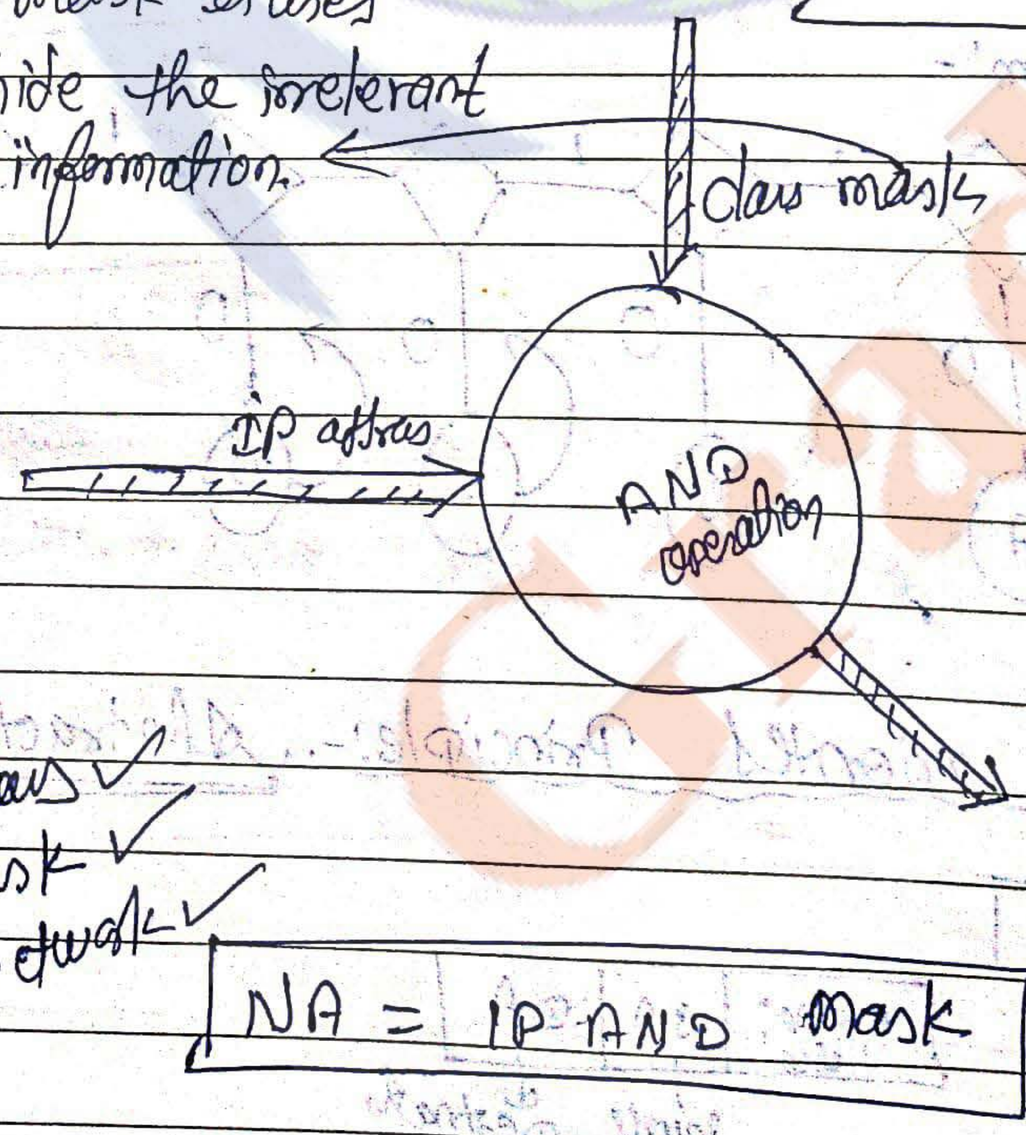
1 1 0 0 1 0 0 0 . 0 0 0 0 0 0 0 1 . 0 0 0 0 0 0 0 1 . 0 0 0 0 0 0 0 0

200.1.2.0

host id को पीपाते के लिए सारे को 0 कर दिया

masking हो गया

Note: mask is used to hide the irrelevant information.



default mask of
class A ; 255.0.0.0
class B ; 255.255.0.0
class C ; 255.255.255.0

128 64 0

1 0 0

IP → class ✓
→ mask ✓
→ Network ✓

NA = IP AND mask

ge No.: _____

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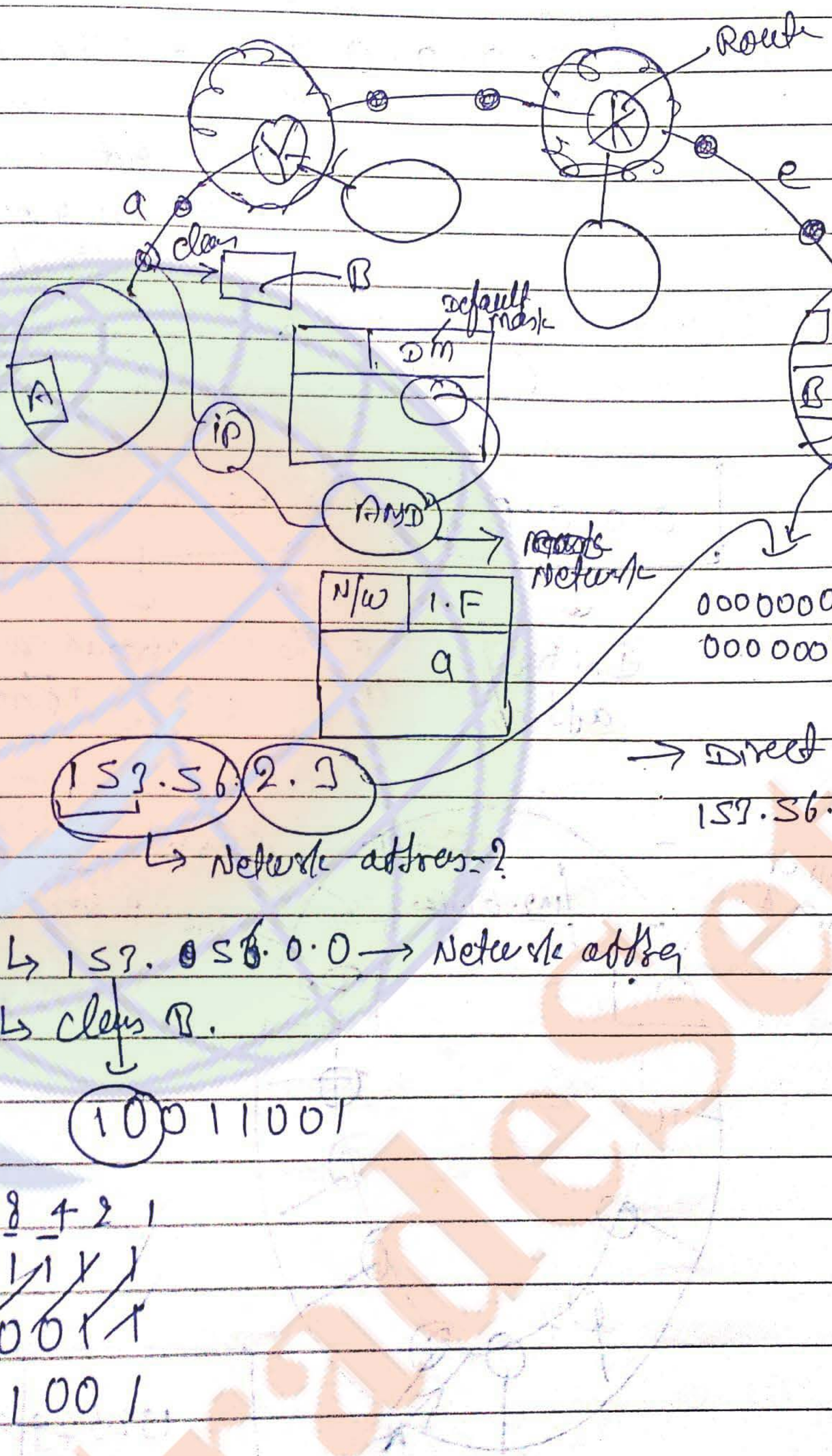
class C :-

*



0. 00000010 00000011

111 1111 . 1111 1111 . 0000 0000
255 255 0

host id को चीपाई के लिए सारे को 0 कर दिया

0000 0000

0 0000 0010 . 0000 0000

↳ 157.56.0.0 → Network address

↳ class B.

mask of

'1

0.0

1

5.0.0

1

5.255.0

1 0 0 1 1 1 0 0 1

0

128 64 32 16 8 4 2 1

1 0 0 0 1 1 1 1

0 0 1 0 0 1 1

1 0 0 1 1 0 0 1

225.255.255.2055

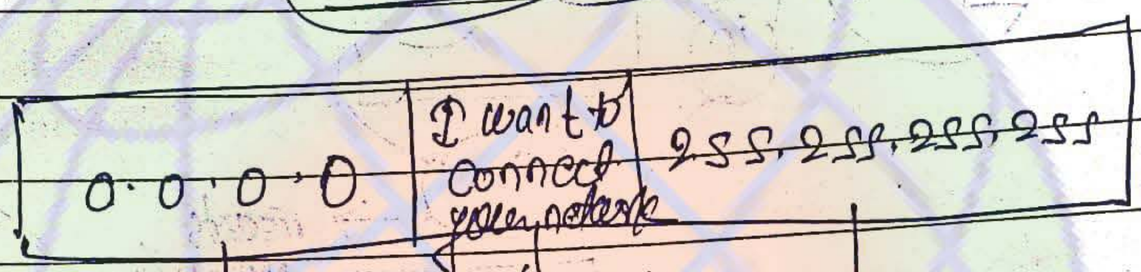
for broadcast

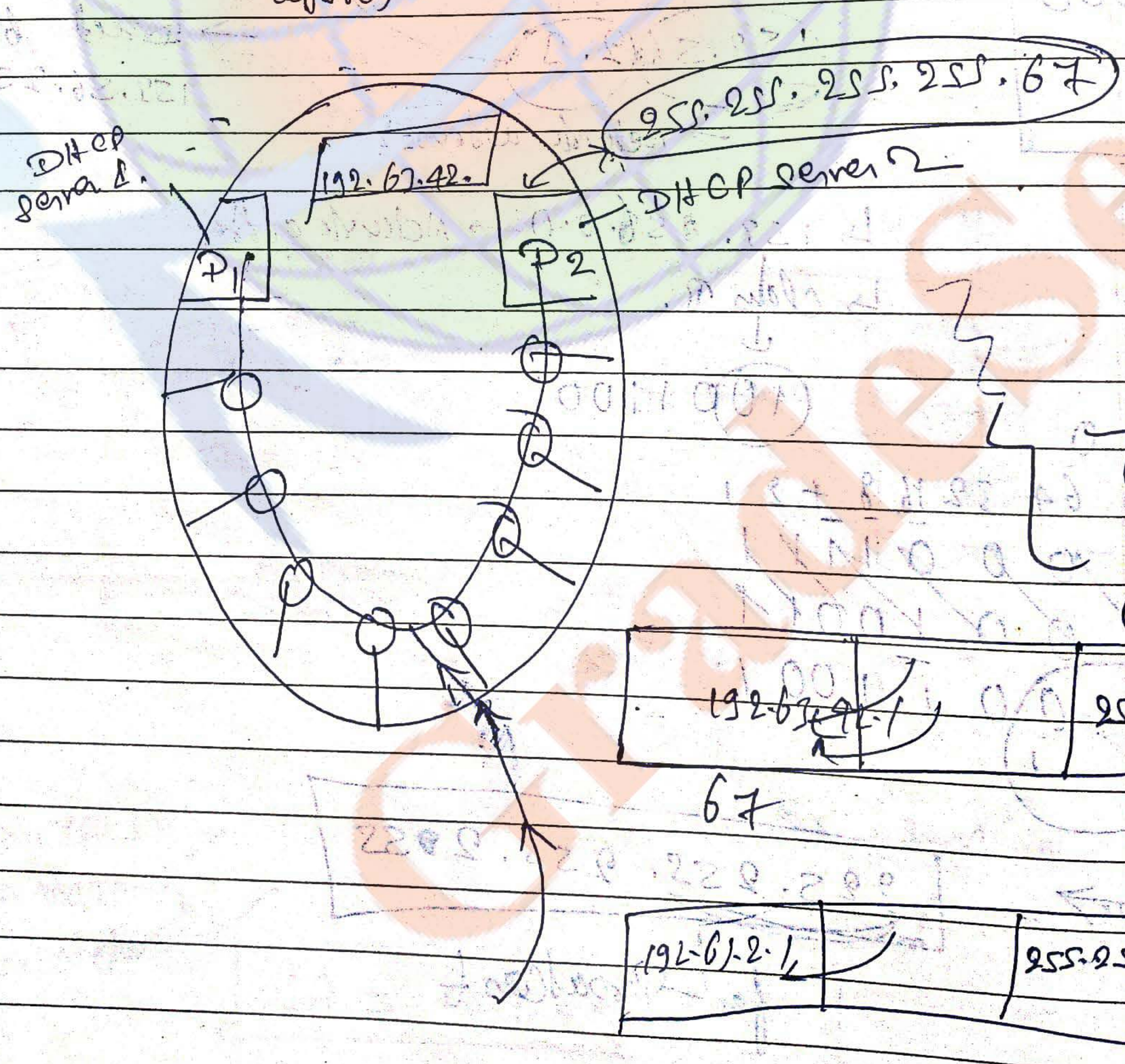
"Cultivation of mind should be the ultimate aim of human existence." —B.R.Ambedkar

Date ___/___/_____ Page No.: _____

0.0.0.0 → This is a valid IP. But with the help of this IP you not able to validate.

DHCP → server → This (3rd) protocol of Application layer





8.7 P

$2^{16} = 64,000$

(Applicat... at one ...

ge No.: _____

valid

e help of
t able

tocol of
pplication
layer

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Port no.

UDP - 67, 68
↓ ↓
client server

* http
DHCP
DNS
TELNET
these are four protocol's of application layer.

AEROSPIKE → database है, एक NOSQL है

→ default port: → 3000

87 Port: (16 bit)

$2^{16} = 64,000 = 64K$
(Applicable at one time)

Telnet:
127.0.0.1:3000
→ connected होने पर connected दिखाएगा।

127.0.0.1 : Port

127.0.0.1 : Port

"Do not say, 'It is morning,' and dismiss it with a name of yesterday.
See it for the first time as a newborn child that has no name." — Rabindranath Tagore

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(11)

Port no :- 16 bit number

0 to 1024 → These are reserved.

Server port

(12)

(8) MAC :- 48 bit

IP :- 32 bit

PORT :- 16 bit

↳ Socket address.

(13)

(9) MAC :- Media access control

↳ a physical address

NIC → एक ऐसा card जो network से connect करते समय use करते हैं।

(10) 127.0x.y.z

127.0.0.1 → loop back address.

(14)

→ यह network से वापिस आ जाएगा।

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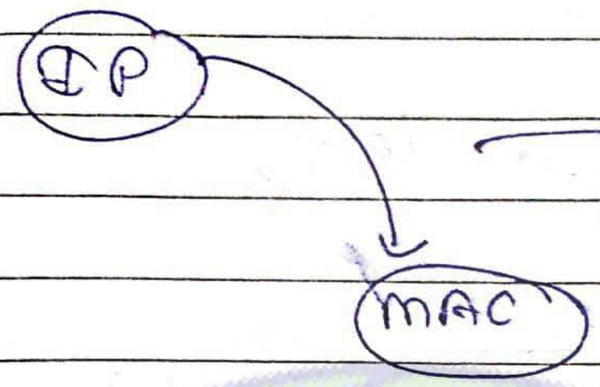
(11) ARP :- Address resolution protocol

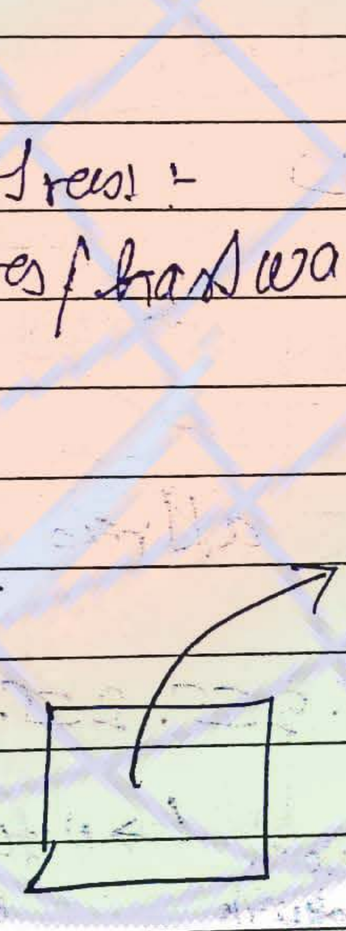


— IP से mac address का resolution.

(12) IP Config :-

IP address :-
mask :-
Broadcast address :-
mac address / hardware address :-

(13) ~~Ping~~



(14) RAP :- Reverse address resolution Protocol

"Do not say, 'It is morning,' and dismiss it with a name of yesterday.
See it for the first time as a newborn child that has no name."

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15 1995 when IPv4 ei lost, then,

NAT

↳ Telephone system
↳ 10^{10}

(16) NAT → Network address translation

10 ⇒ 1

10.0.0.0 to 10.255.255.255 ✓

All possible combination of host

126 - 1 = No of network address available

↳ Network address that used in Private address :- 1

Private address
16, 17, 18 --- 31 = 16

172.16.0.0 to 172.31.255.254 ✓

class B

914 ÷ 16 = No. of Network address available

↳ 16 ✓

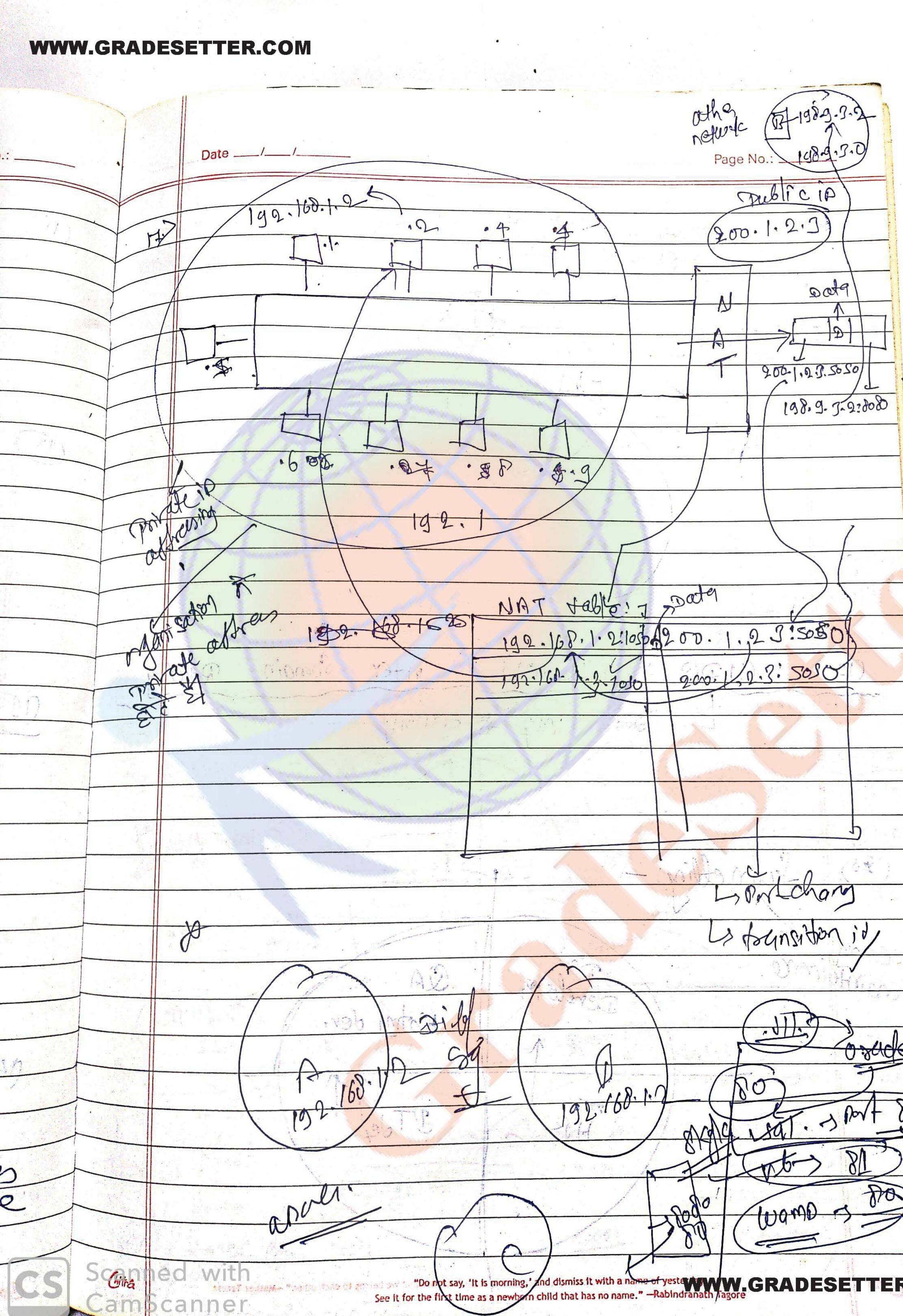
0, 1 --- 255 = 256

192.168.0.0 to 192.168.255.254

class C = 24 bits

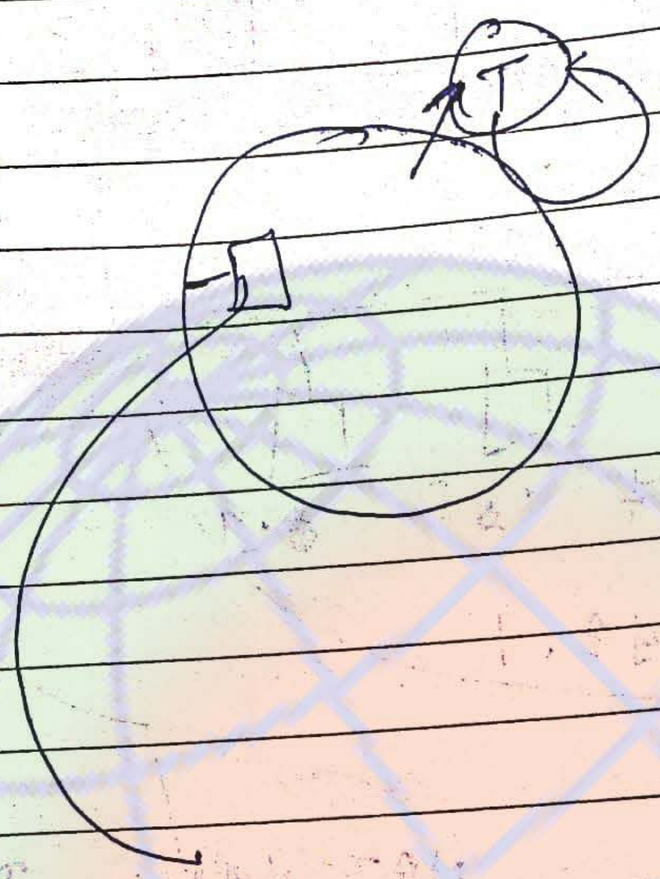
↳ 256

$2^{21} - 255$ = No. of Network address left from before



Date __/__/____ Page No.: Date

* "City — Temp"



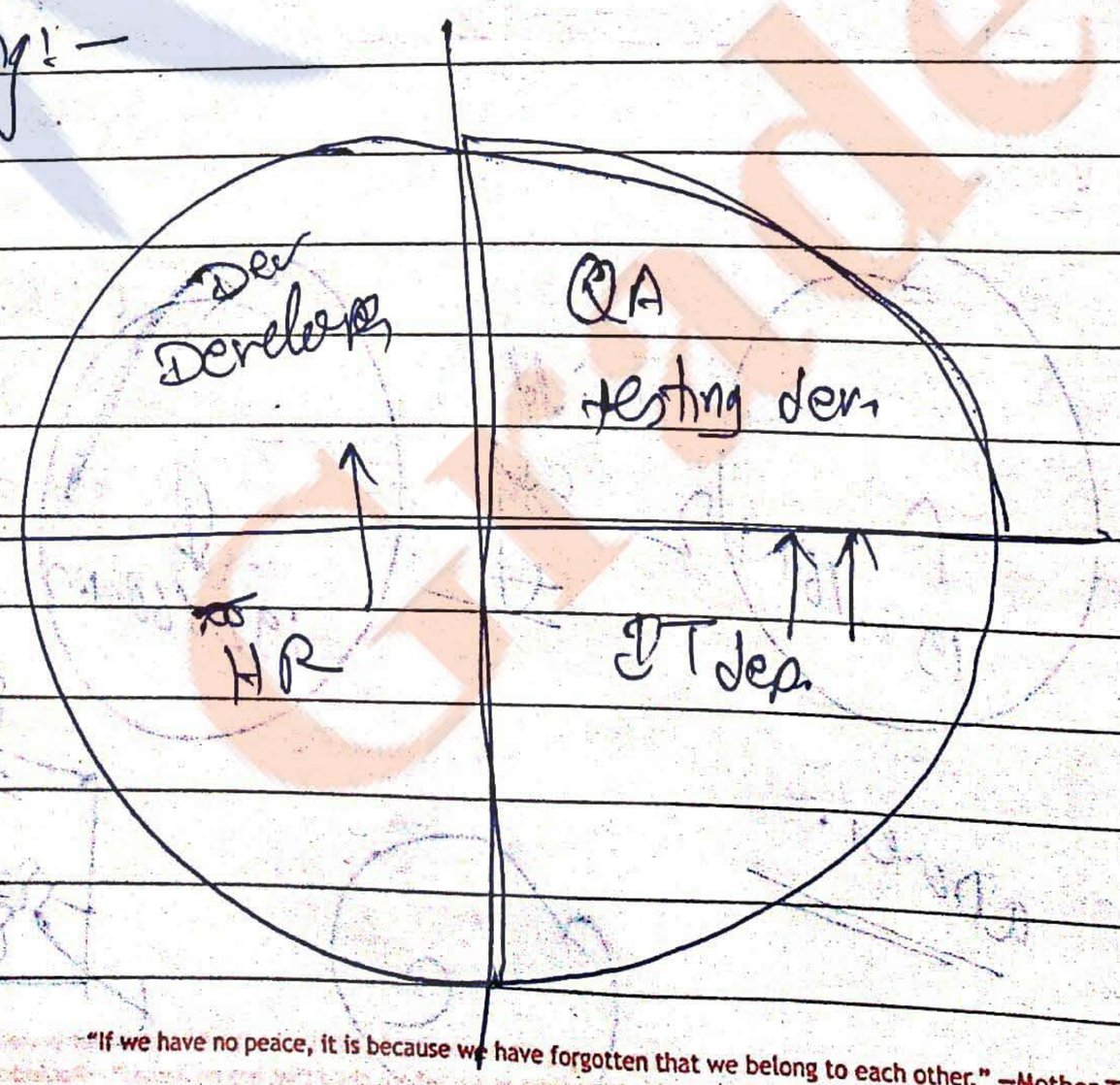
(18) Proxy

(19) CIDR :- Classless inter domain Routing.

↳ जिसमें IPv4 को बचाया।

(20) Subnetting :-

easy maintainence.



for subnetting

20

20

0

This Δ b
is use
identi

Subn

"If we have no peace, it is because we have forgotten that we belong to each other." —Mother Teresa

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200.1.2.0 ⟷ Network address

No of host = $2^8 - 2$

= 254

8 bits

8 bits

⇓

In reality

⇓

200.1.2.0

NA = 200.1.2.128

DBA → 200.1.2.255

1st - 200.1.2.129

↓

10000001

Range :- 200.1.2.129 to 200.1.2.254

mask :- 255.255.255.128

200.1.2.1 _ _ _ _ _ _ _

1 _ _ _ _ _ _ _

7 bits

200.1.2.127 → Broadcast

200.1.2.128 → Network address

for subnetting reserve for host

200.1.2.0 _ _ _ _ _ _ _

127 — 127

200.1.2.0

0 _ _ _ _ _ _ _

7 bits

host

This 1 bit is used for identification of subnet.

mask :- 255.255.255.128

Directed broadcast address

200.1.2.01111111

for broadcast

Ranges →

200.1.2.1 → 00000001

to

200.1.2.126

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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Logic to find mask:I

200.1.2.0 _ _ _ _ _ _ _ _

↓ ↓↓ ↓

(1) → logic अवगड भी Network का id ही चुका है

11111111

255 . 255 . 255 . 128

11111111 , 11111111 , 11111111 , 10000000

* IP address

(255.255.255.17) — mask है

255.255.255.00010001

→ 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1

200 . 3 . 3 . 27

00011011

0 | 0 | 0 | 1 | 1 | 0 | 1 | 1

AND operator

NA:→ 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1

200.1.2.10000001

200.3.7.7

8(2)

To perform any kind of operation id ई important है (जितने position पर 1 है उतनी value fill करें)

No of 1 कितने sub net बनेंगे / 1 border भी होते हैं

Q) IP a

So/n

128 64 32 16 8

1

1 1 0 0

Date __/__/____ Page No.: ____

Q) IP address: 192.[illegible]192.192.200

mask: 255.255.255.16

find (a) No. of bit's borrowed ⇒ 1
(b) sub-net id = [illegible]
(c) No. of host per subnet = $2^4 - 2$
(d) No. of subnet's = 2
(e) [illegible] DBA

Sol/

255.255.255.16

16 → 0 0 0 1 0 0 0 0

1 bit responsible for 2 subnet (0, 1)

255 | 128 64 32 16 8 4 2 1

1
1 0 0 1 0 0 0

1 0 0 0 1

1 0 1 1

1 0 0 1

Borrowed bit position.

192.192.192. — — — 1 — — — —

— — — 1 — — — —

200:-
200 → 1 0 0 0 0 0 0 0

AND operation:-

0 0 0 0 0 0 0 0 → DBA

sub-net
(192.192.192.0)

• Subnet mask:- It is used to find out no. of bit's borrowed from the host id part and there exact position.

Based on the following rules:-

Rules:- No. of 1's in a subnet mask indicate network id part and

"Do not say, 'It is morning,' and dismiss it with a name of yesterday.
See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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borrowed bit's parts.

Rule 2 :- No. of 0's indicate host id part.

Sol/7

Q) given mask :-
given IP :-

AND operation.

Net id / subnet id

128 64
1 0
1 2 8

0 0 0 1 0 0 0 0
AND 1 1 0 0 1 0 0 0
0 0 0 0 0 0 0 0

1st addres :-

192.192.192. 0 0 0 0 0 0 0 1

↳ Reserved

Direct Broadcast addres :-

192.192.192. 1 1 1 1 0 1 1 1

mask :-

255.255.255. 0 0 0 0 1 0 0 0

16

Date __/__/____ Page No: ______

Q.7 IP address :- 192.192.192.200
mask - 255.255.255.72

(a) No. of bit's borrowed. = 2
(b) 192.192.192.72
(c) $2^6 - 2$
(d) 4
(e) 192.192.192.255

Sol 7

255.255.255.72

128 64 32 16 8 4 2 1

0	1	0	0	1	0	0	0
1	1	0	0	1	0	0	0

AND:-

0 1 0 0 1 0 0 0

128
32
16
7
183

192.192.192. 1001000

1st address.

0 1 0 0 1 0 0 1

DBA! -

1 1 0 0 1 0 0 1

mask -

0 1 0 0 1 0 0 0

64 8

"Do not say, 'It is morning,' and dismiss it with a name of yesterday.
See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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0-127
128-191

Class B

Q) ip: 150.100.100.100

mask - 255.255.255.0

128 64 32 16 8 4 2 1

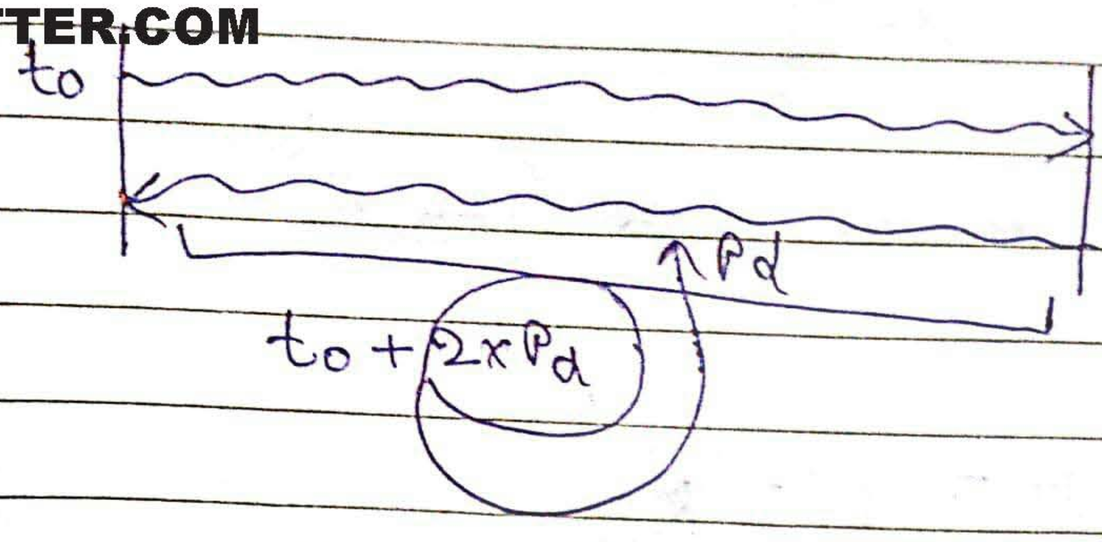
128
64
32
96

150.100.100.100
255.255.255.0
150.100.100.0

150 → 1 0 0 1 0 1 1 0
100 → 0 1 1 0 0 1 0 0
100 → 0 1 1 0 0 1 0 0
0 → 0 0 0 0 0 0 0 0

255 → 1 1 1 1 1 1 1 1
mask - 0 0 0 0 0 0 0 0
DDA: 1 1 1 1 1 1 1 1
Ans: 0 1 1 0 0 1 0 1

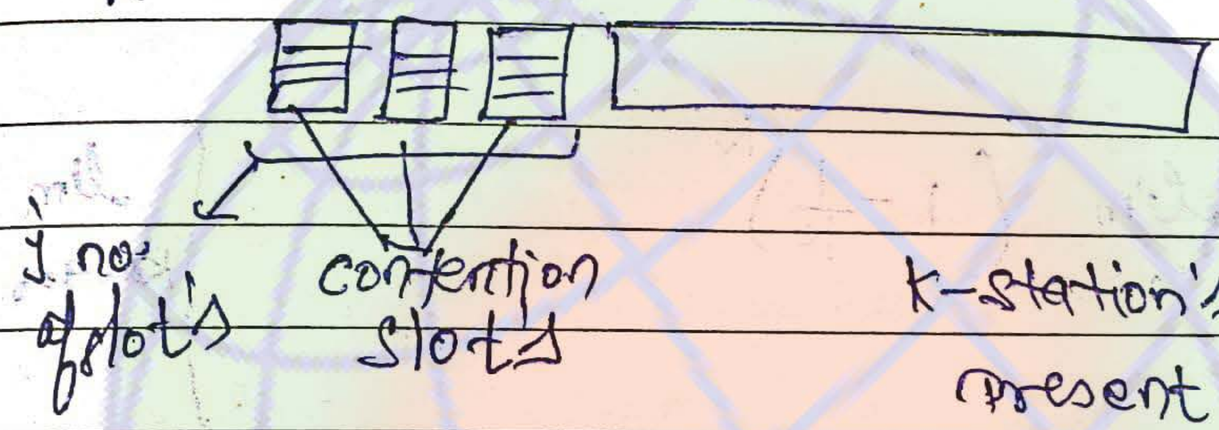
(a) 8
(b) 150.100.100.0
(c) $2^8 \cdot 2$
(d) ~~150 100 100 255~~
(e) 150.100.100.255



Contention Period

↳

A



k-station's are already present to transmitte their data into the particular contention slot.

P - Probability

Probability of success! - $K_{C_1} (1-P)^{K-1}$

(A) $= K(1-P)^{K-1}$

$$\boxed{A = K(1-P)^{K-1}}$$

Probability of success

Q For what value of P, A would be maximum?

$$\frac{dA}{dP} = K\left\{(1-P)^{K-1} + P(K-1)(1-P)^{K-2}\right\} = 0$$

$$= (1-P)^{K-1} - P(K-1)(1-P)^{K-2} = 0$$

$$\Rightarrow (1-P)^{K-1}\left((1-P) - P(K-1)\right) = 0$$

$$(1-P) - P(K-1) = 0$$

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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$$P = \frac{1}{e}$$

$$A = \left(1 - \frac{1}{k}\right)^{k-1}$$

$$\lim_{k \to \infty} \left(1 - \frac{1}{k}\right)^{k-1}$$

$$\lim_{k \to \infty} \left(1 - \frac{1}{k}\right)^{k} \left(1 - \frac{1}{k}\right)^{-1}$$

$$\lim_{k \to \infty} \left(1 - \frac{1}{k}\right)^{k}$$

$$e^{-1} = \frac{1}{e}$$

$$\boxed{A = \frac{1}{e}}$$

Probability of success.

$$\boxed{Pr(j) = A(1-A)^{j-1}}$$

j = No. of slots required.

$$\lim_{k \to \infty} \left(1 + \frac{x}{k}\right)^{k}$$

$$e^{x}$$

Expected no. of slots required

$$\sum_{j=1}^{\infty} j\, Pr(j) \quad ; M = \sum_{j=1}^{\infty} j \times A(1-A)^{j-1}$$

$$M = \frac{1}{A}$$

mean number of slots

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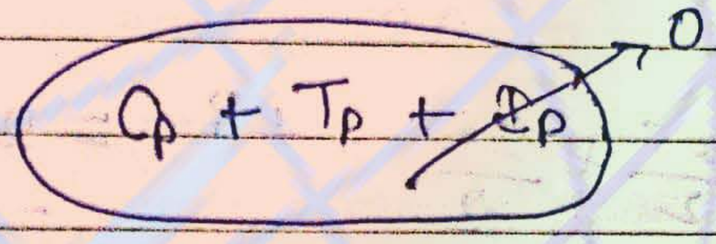
$$A = \frac{1}{e}$$

$$m = \frac{1}{A}$$

m = mean no. of slot's so,

$$m = e$$



$$\text{efficiency}(\eta) = \frac{P}{P + 2 \times P_d \times e}$$

where

P = mean no. of frames taken P times to transmitte.

$$\eta = \frac{T_t}{T_t + 2 \times P_d \times e}$$

$$= \frac{1}{1 + 2 \times \left(\frac{P_d}{T_t}\right) \times e}$$

$$\eta = \frac{1}{1 + 2ae}$$

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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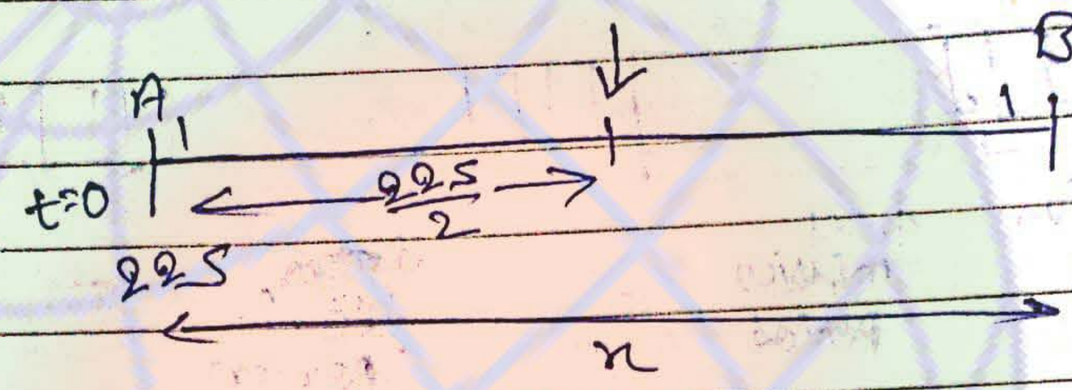
Q) Suppose node A and B are on the same 10 mbps ethernet segment and propagation delay b/w the two node is 225 bit time. suppose A and B send frame at t=0 the frame collides then at what time A or B finish this transmitting A jamp signal. Assume that jamp signal is 48 bit

Sol^n



$$\frac{225}{2} + \frac{225}{2} + 48 = 225 + 48$$
$$= 273$$

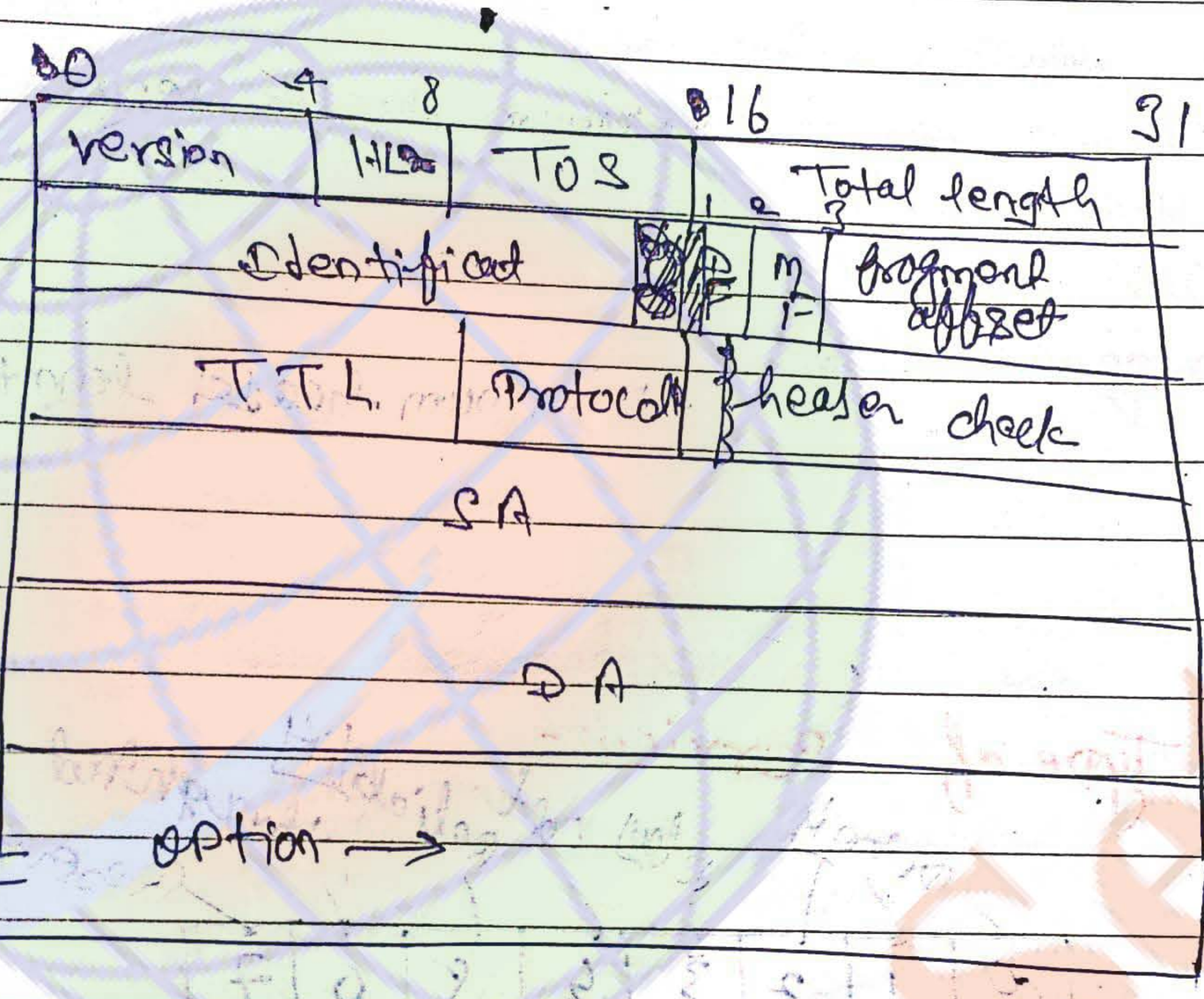
273
225

Network layer:-

① IP:- (Internet Protocol)

Protocols:- IP, ICMP, IGMP, ARP, RARP, BGP, OSPL, RIP

② IP header formate:-



(i) Version:- The version field will keep track of which version of the protocol, the datagram belong's to.

eg IV4 version or IP6 version.

(ii) Header length:- It is used to know the length of the header. It is of 4-bit and each number in header length indicates 4-byte word. So if header length is equal to

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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to 5.

0000
0001
0011
0100
0101

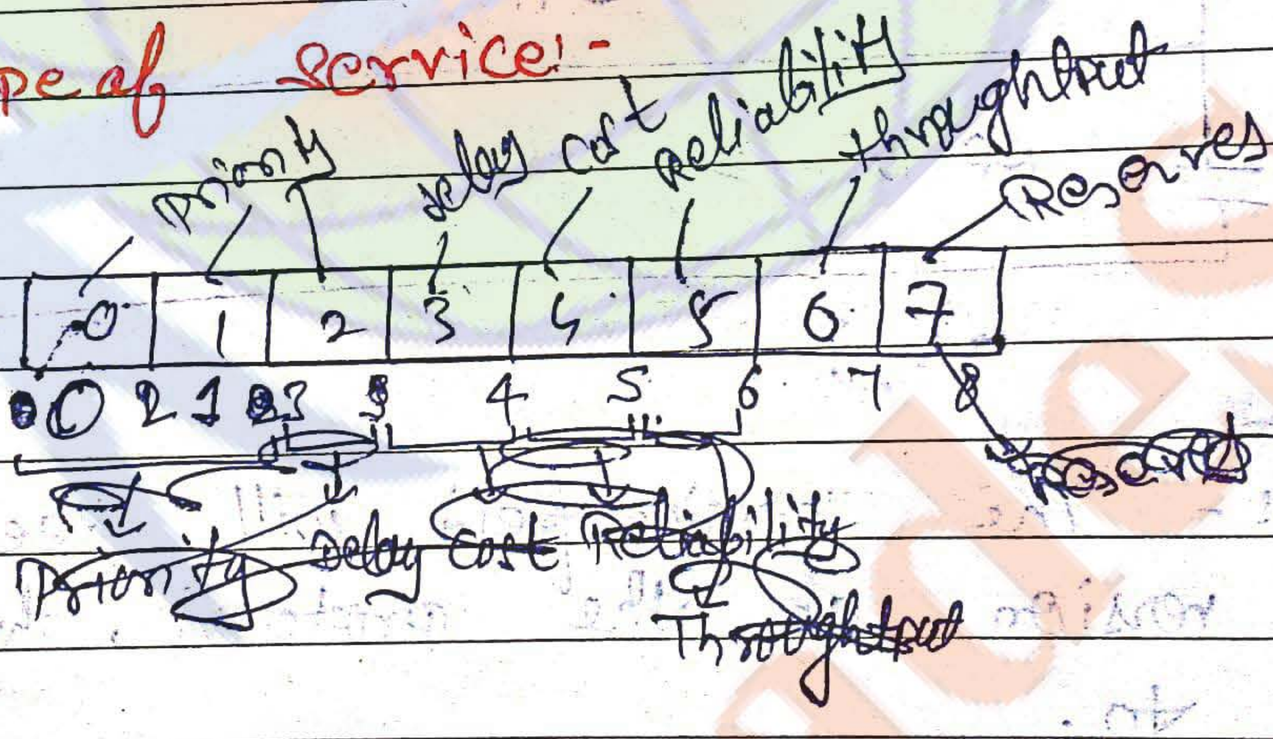
minimum = 20 Byte

✓ maximum header length = 11111
= 15 x 4
= 60 byte

✓ minimum header length = 0101
= 5 x 4
= 20 byte

= 5 x 4 Byte
= 20 Bytes.

- Type of service:-



If more than one packet's are accumulated at router and router need's to pin up their buffer in that case packet having less priority will get discarded.
of delay bit is set to 1, that mean's that the packet in such a way

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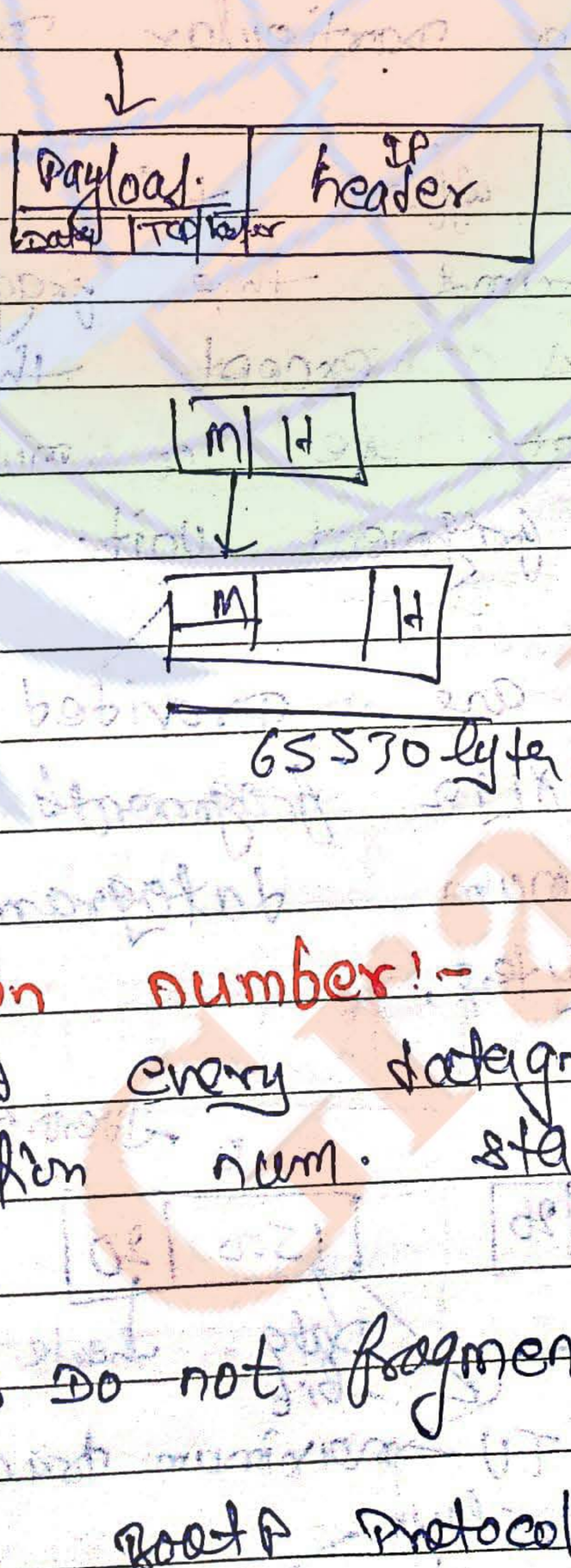
that the delay is less.
If cost bit is equal to 1, then choose the root for packet which gives less cost and
same with reliability and throughput.

- **Total length:-** A total length includes everything in the datagram both header and data the maximum length is 2^{16} which is 65,535 bytes. at present this upper limit is tolerable but with future gigabit networks larger datagram's may be needed.

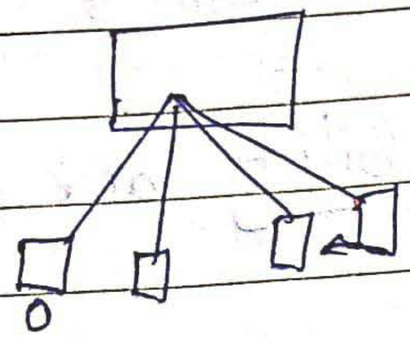


- **Identification number:-** each and every datagram will use a an identification num. starting from 0 to 64k.

Note: D / F ⇒ Do not fragment

Boot P Protocol

M
F → more fragments.

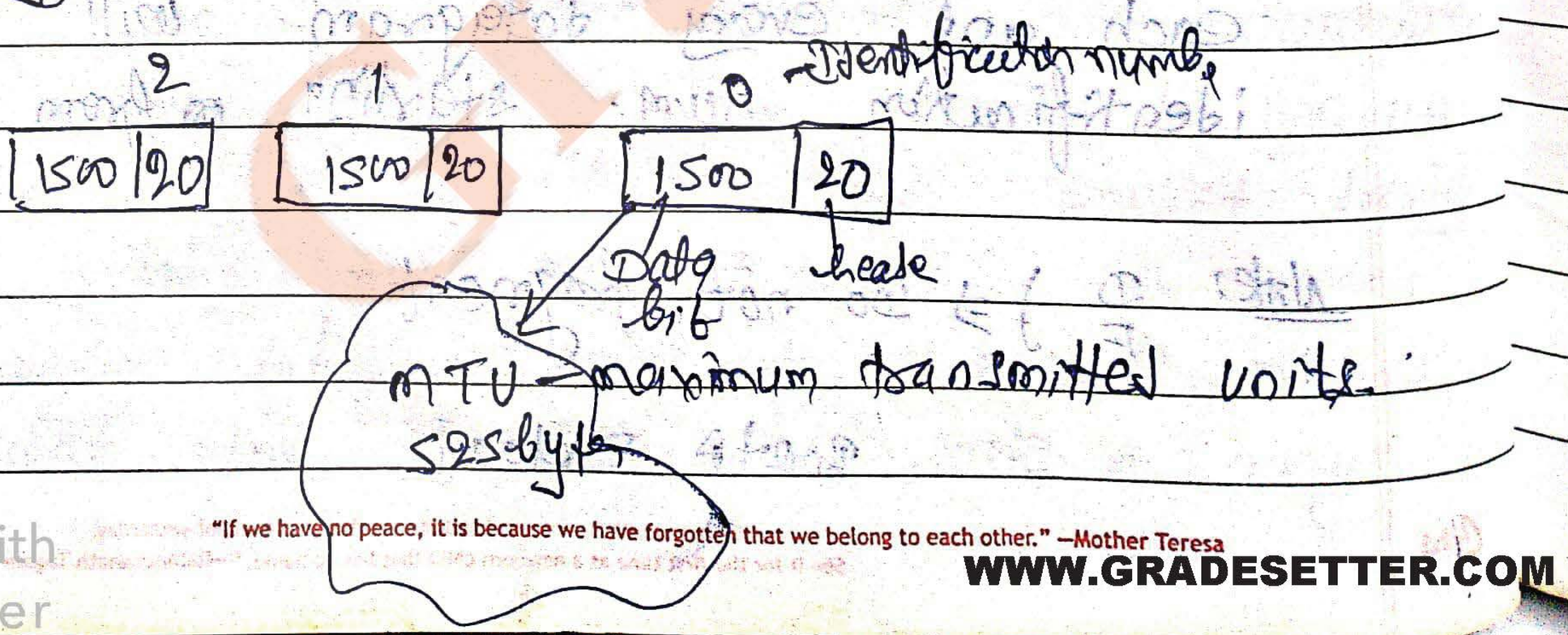


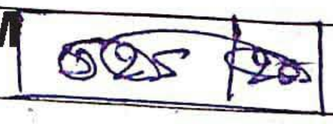
0
(when MF bit is zero then it means it is last bit.)

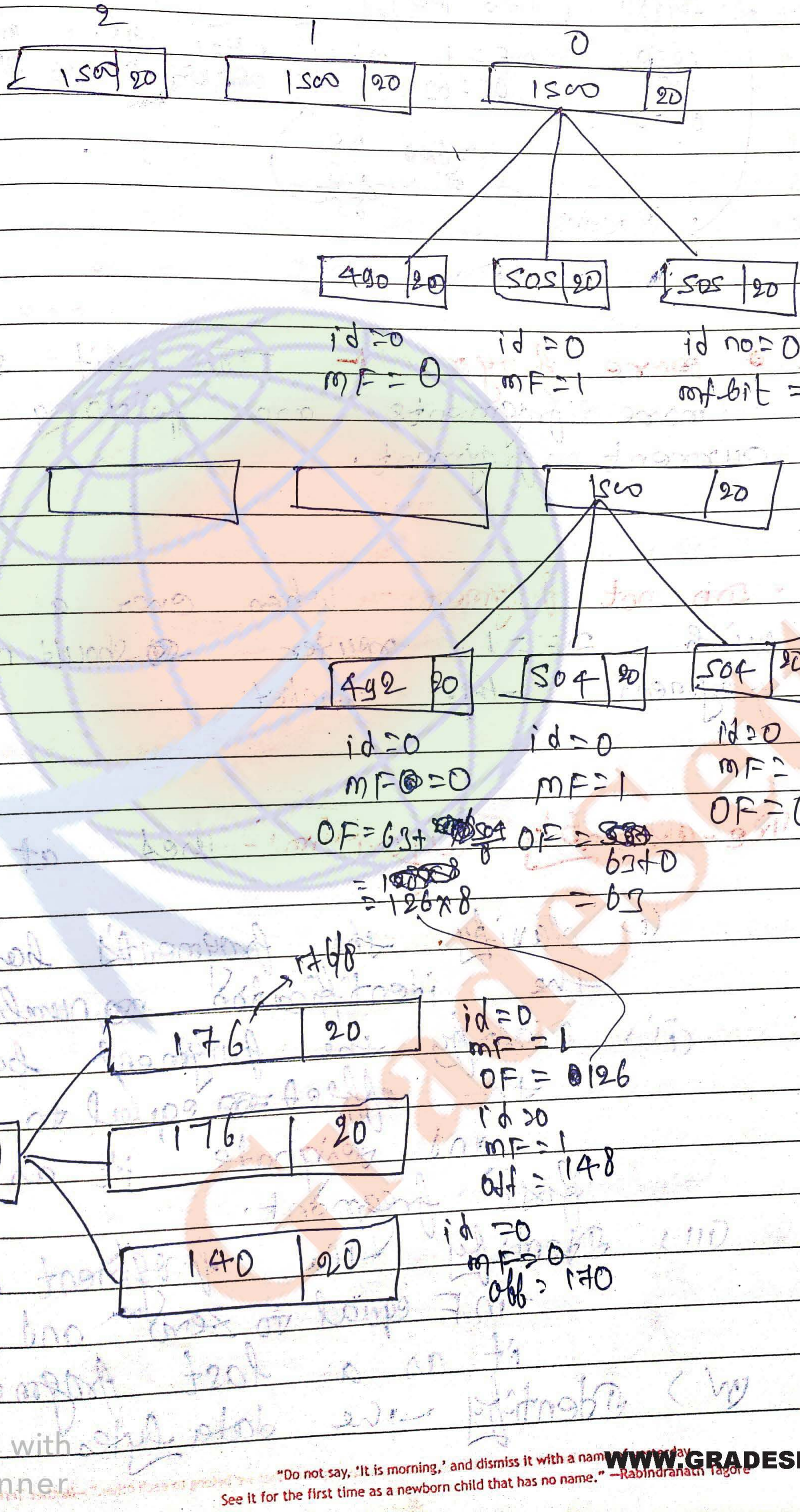
- **offset:-** This field is used to know how many data bytes are ahead of this fragment in a particular packet.

The fragment offset tells where in the current datagram this fragment belongs. All fragments except the last one in a datagram must be a multiple of 8 bytes, the elementry fragment unit.

Since 13 bits are provided, there is a maximum of 8192 fragments per datagram giving a maximum datagram length of 65536 bytes.







"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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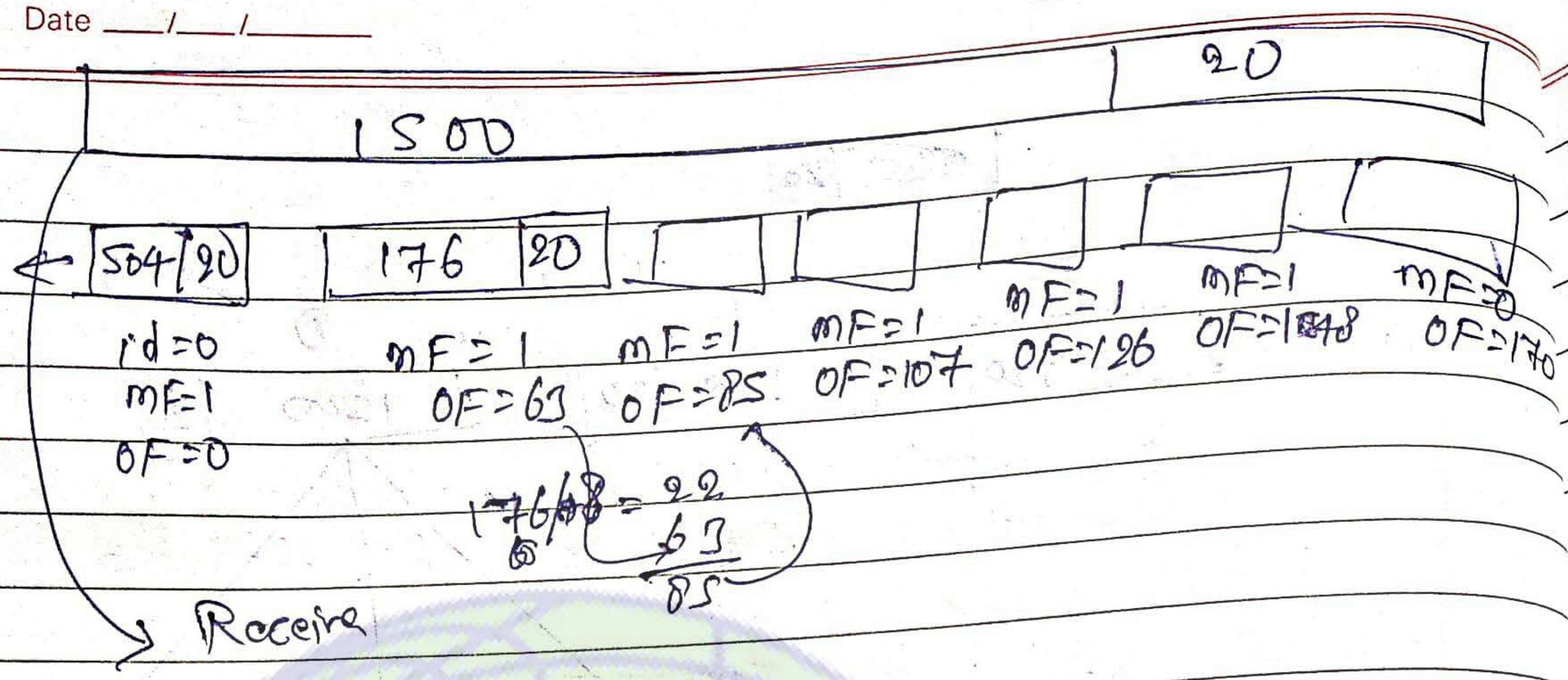

- **more fragments**:- This bit says if more fragments are following the current fragment.

- **Do not fragment**:- when ever a packet with DF=1, router should not fragment this packet.

- **Re-assembly algorithm**:- used at destination.

  (i) classify the fragments based on the identification number

  (ii) Identify the fragment based on the offset equal to '0' (zero) and designate it as a first fragment.

  (iii) Identify the fragment with MF equal to zero and designate it as a last fragment.

  (iv) Identify the data bytes in the

(3)

DHCP
Boot
RARP

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first fragment and divide it by 8, and search for a fragment with same offset and designate it as a second fragment.

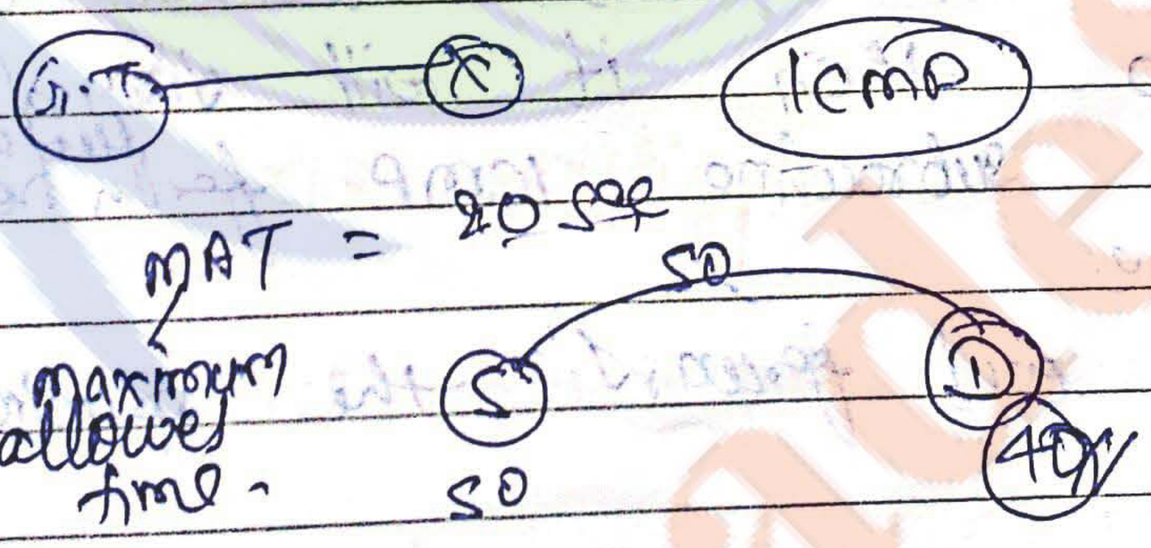
(iv) Divide the databytes of 2nd fragments and result should be added with it's offset value will gives you offset value of next fragment.

(v) Repeat the previous step till completion.

(3) TTL (time to live) :-

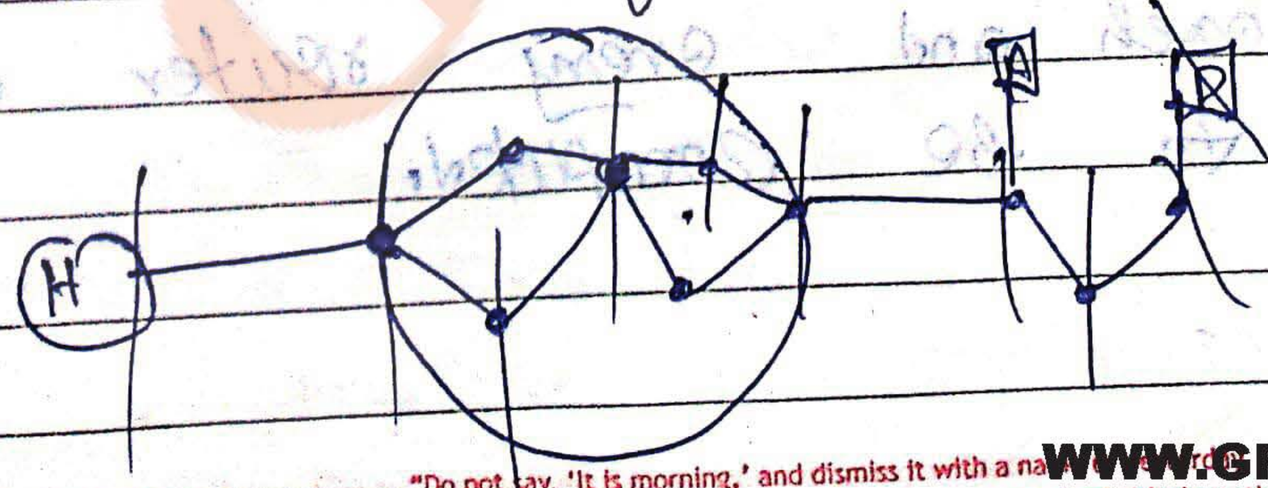
DHCP
Bootp
RARP

Time Stamp :-



Hop Count :-

= Diameter of the network



It is used to avoid infinite looping into the network. This can be implemented in two ways.

(i) Time stamp:- In this approach ~~host~~ will stamp ~~the~~ generation time of the packet and when this packet reach to the router, it will substract it's generation time from it current time and resultant value is compared with the maximum allowed time of the packet. If resultant value is less than maximum allowed time the packet will be forwarded through outgoing link. else the packet will be discarded and ICMP will come into the picture.

(ii) Hop count:- At host the value of hope count will be initialised by maximum distance b/w source and distination or with the diameter of the network.
when the packet reach at router, router will decrement it's hope count by 1, and check whether hope count value is 0 or less than 0, If so then it will discard the packet and call subroutine ICMP for further necessary action else
It will forward the packet to outgoing link.

(3) Protocol field:-
It is used to identify the service.

(4) checksum:-
At each and every router checksum have to be computed.

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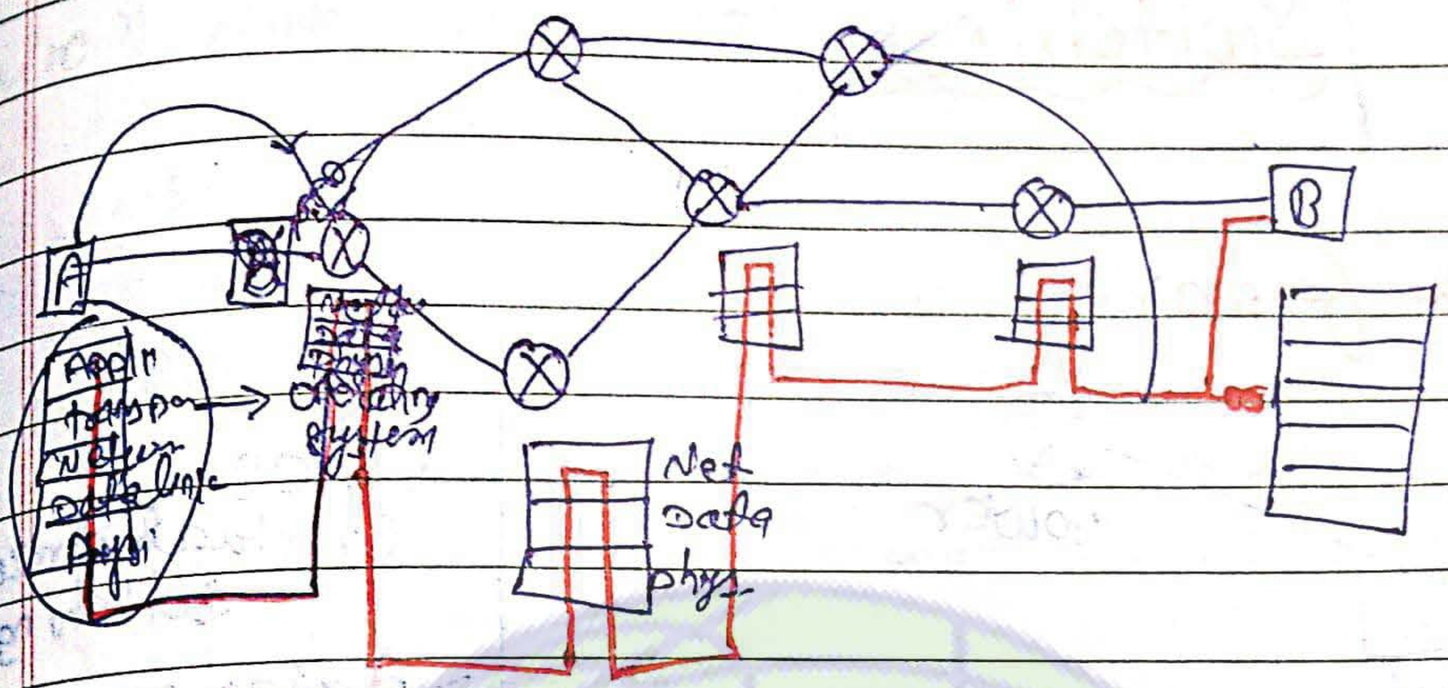

Network layer = 6

Data link layer = 10

At each and every router checksum have to be Computes because some of the field's in IP header may change as the packet makes a journey towards the destination.

MF, TTL, offset, 16 bit datagram length and option's like

(a) strict source routing :-

(b) loose source routing

(c) time stamp values.

(d) Record route routing

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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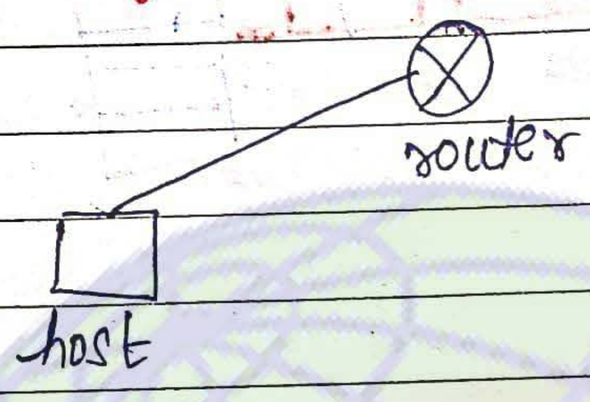
Switching

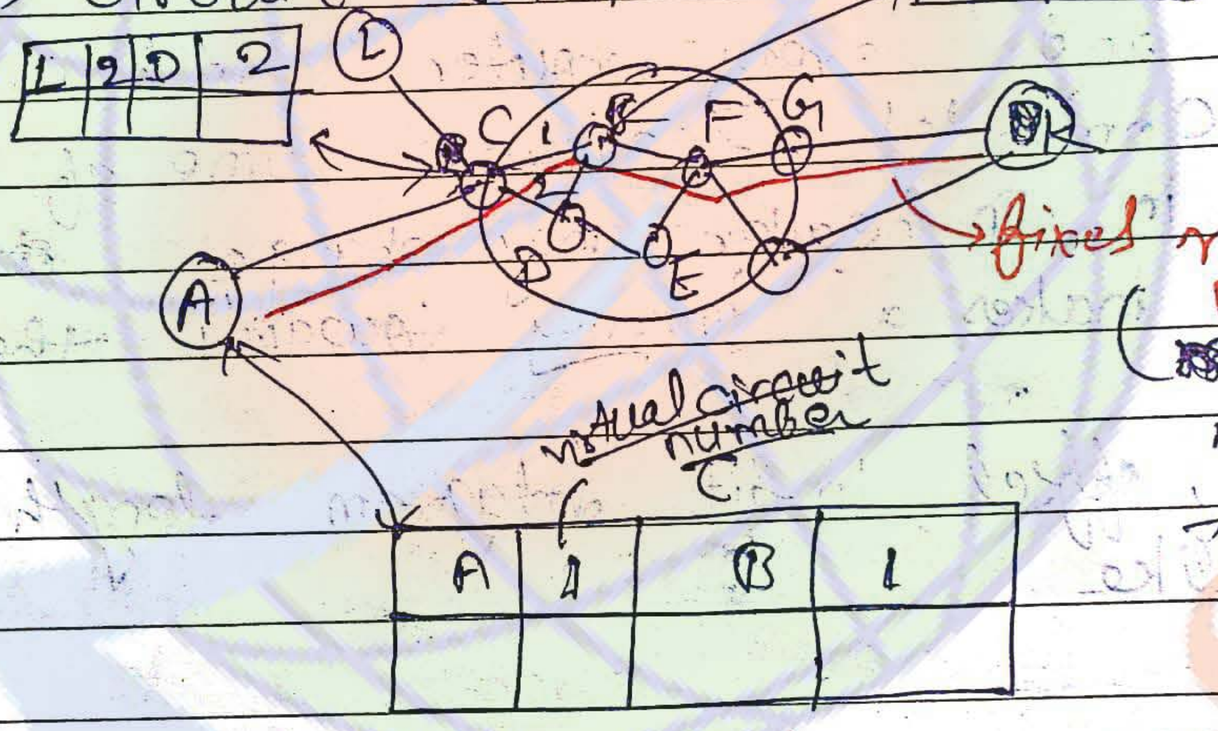
(1) store & forward:-



→ VCS (virtual circuit switching)

→ Datagram switching.

(i) Circuit setup:-



Issues	Datagram	virtual circuit
~~# Datagram~~		
(a) Circuit setup:-	(a) ~~Subnetting~~ not needed	(a) ~~Subnetting~~ required
(b) ~~Stacks~~ information.	each ~~packet~~ contain	
(b) Addressing	each packet contain the full source and destination address	each packet contain a short virtual circuit numb

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(c) State informati	(c) Router's do not hold state inform about the connection.	(c) each virtual circuit exists for connection.
(d) Routing	each packet is routed independently i.e. complicates loop up procedure	route choosen when virtual circuit is setup & packet will follow it

☆ Routing!

- In datagram each packet routed independently.

i.e. Complicated look up process.

☆ virtual circuit:- Rout choosen when virtual circuit will set

(e) • ~~Affect of router failure~~ ~~Quality of~~ affect of router failure.	• non except for packet loss during the crash.	• All VC's that are passed through the fill router as terminated.

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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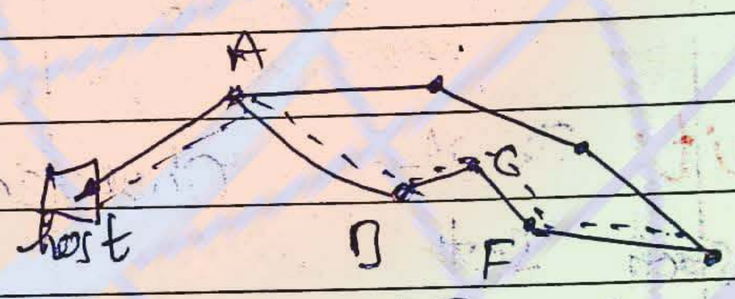
Quality of services: -	• Difficult	easy if enough resources can be allocated in advance

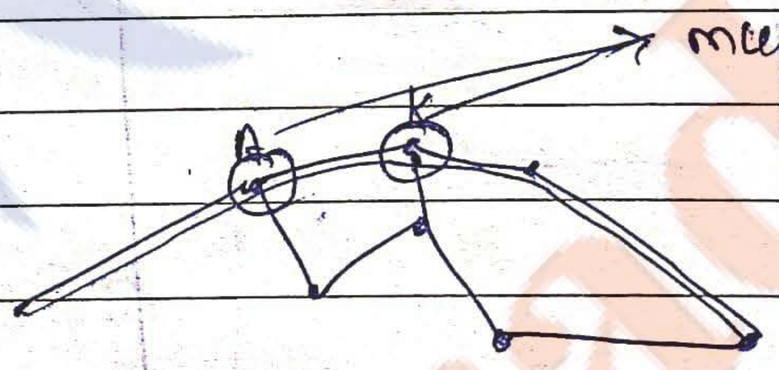
* option fields:-

(i) strict source routing -



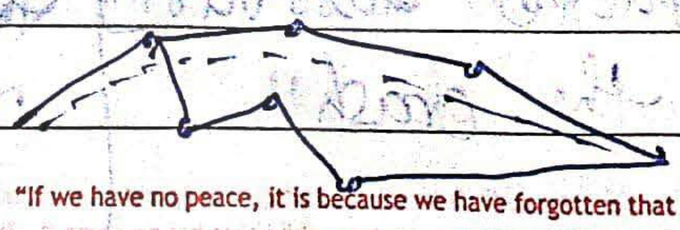
SSR = ABCFG

(ii) loose source routing



(iii) Time stamp values:-

(a) Record route setting -

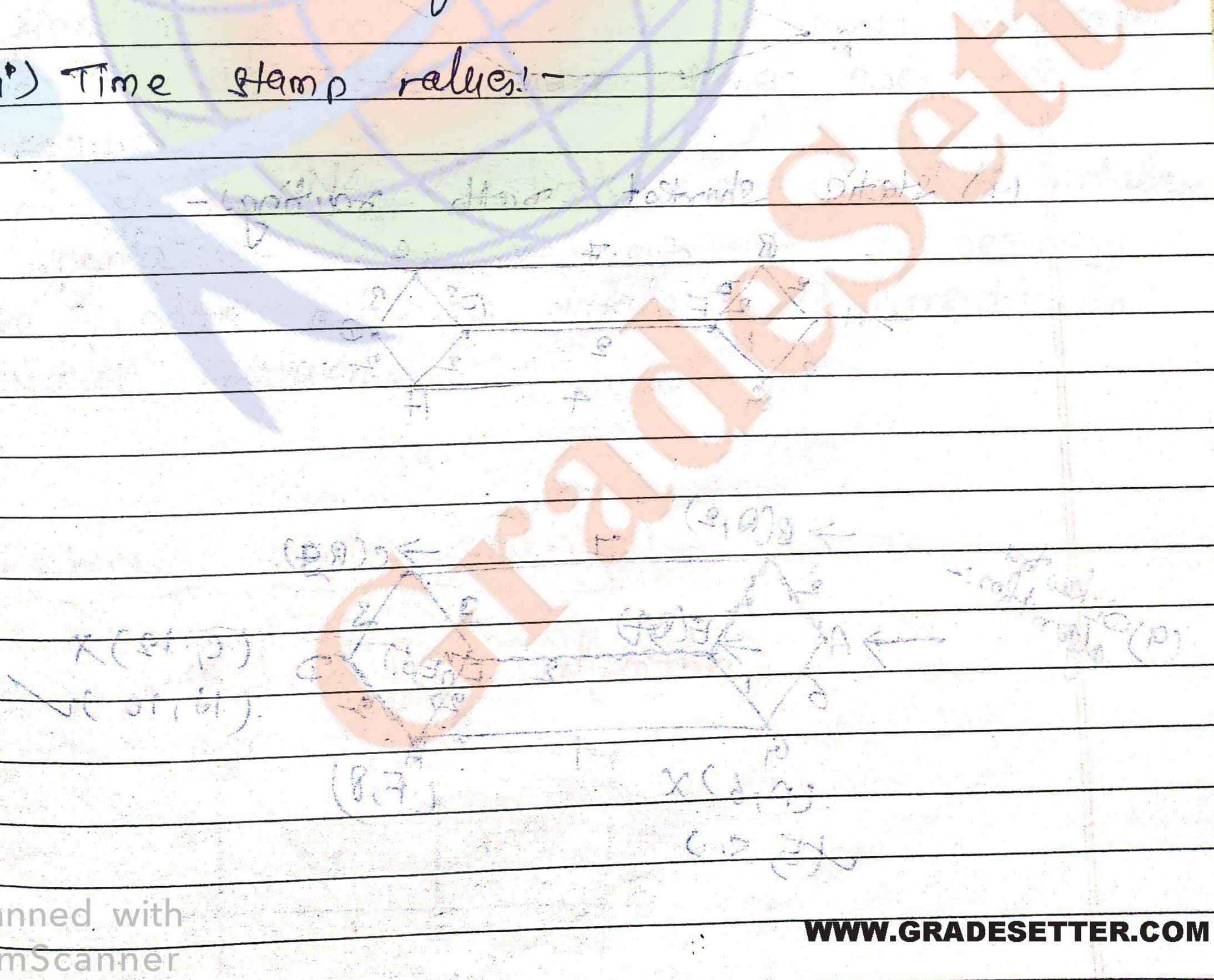


→ choose which have minimum no. of hops.

(i) Strict source routing :-
In strict source routing packet will be forwarded to the next outgoing link based on route provided by the source.

(ii) loose source routine :-
In loose source routing the path provided by source might not be completed or source can specify some set's of routers that must be includes the path of routing.
So, when this packet reaches at router, router will follow atleast the limited path provides by the source or it will traverse the packet via specified routers.

(iii) Time stamp values :-



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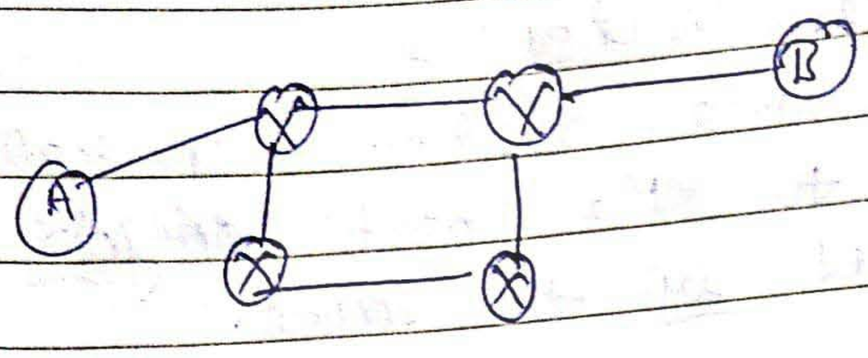
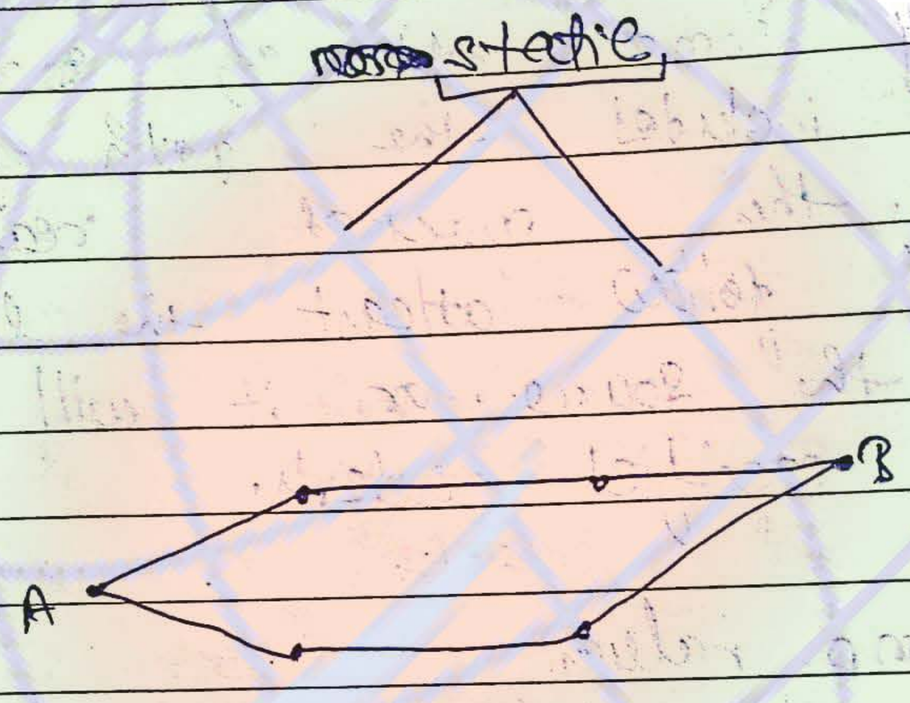
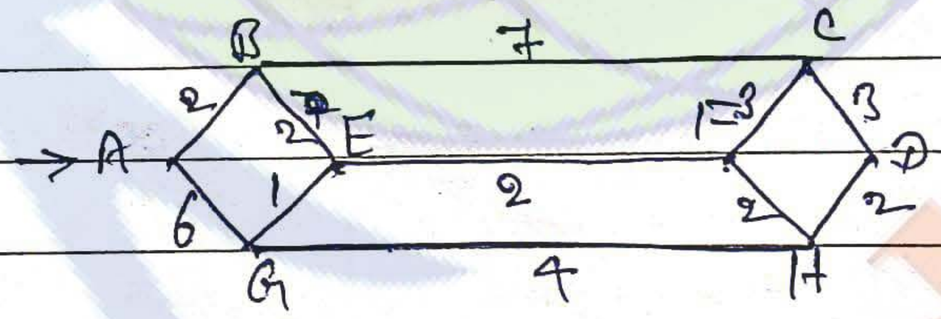
Routing Protocol's



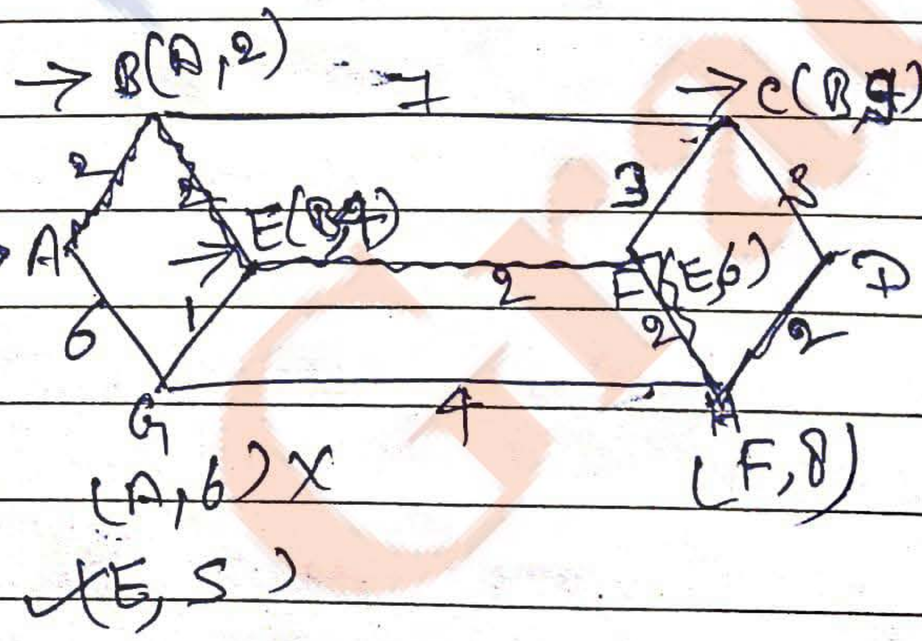
(a) Adaptive (Dynamic)
(b) non-adaptive (static)



(i) Static shortest path routing :-



(9) Dijkstra algorithm :-



"If we have no peace, it is because we have forgotten that we belong to each other." —Mother Teresa

simply broadcasting

(b) Flooding :-

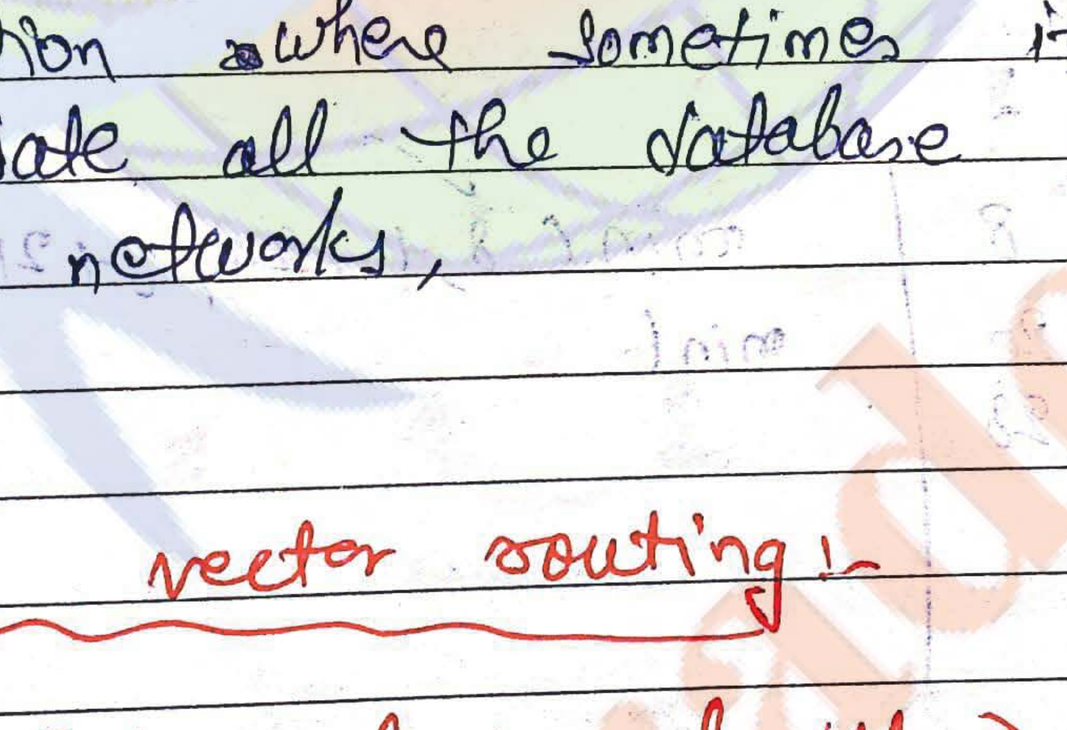
military

Flooding is a static algorithm.
An alternative techniques to find out shortest path b/w source and distination. we use flooding.

A variation of flooding that is slightly more practical is selective flooding.
In this algorithm
router do not send every incoming packets out on every line but only on those line that are going approximately on right direction

flooding is not practical in most application but it theres have some uses. for example.
In military application, in distributes database application where sometimes it is necessary to update all the database concurrently. In wireless networks,

(c) Distance vector routing :-
(Belman ford algorithm)



"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

book:- Tanon bomb

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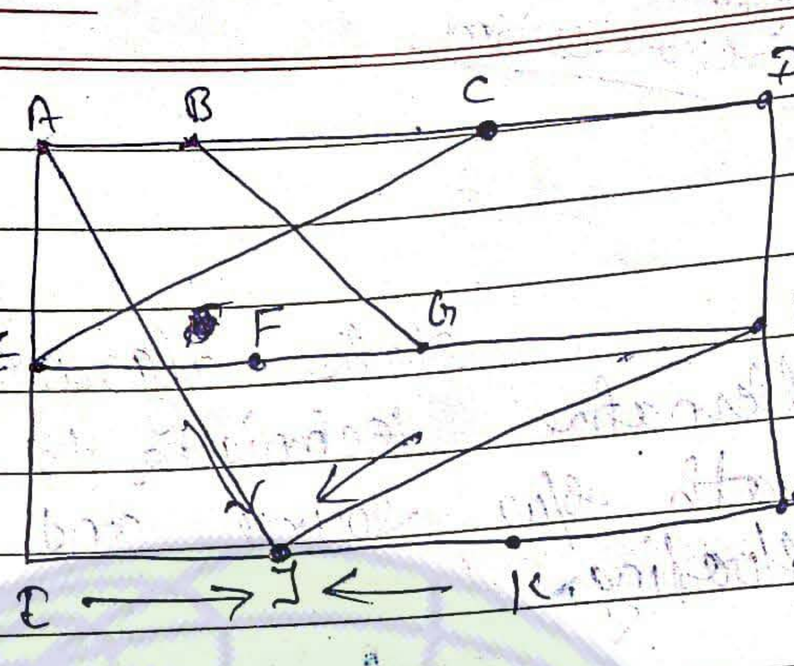
Q.7



	A	C	H	K
A	0	24	20	21
B	12	36	31	28
C	25	18	19	36
D	40	27	8	34
E	14	7	30	32
F	23	20	19	40
G	18	31	6	31
H	17	20	0	19
I	21	0	14	20

J-I = 10
J-A = 8
J-K = 6
J-H = 12

J

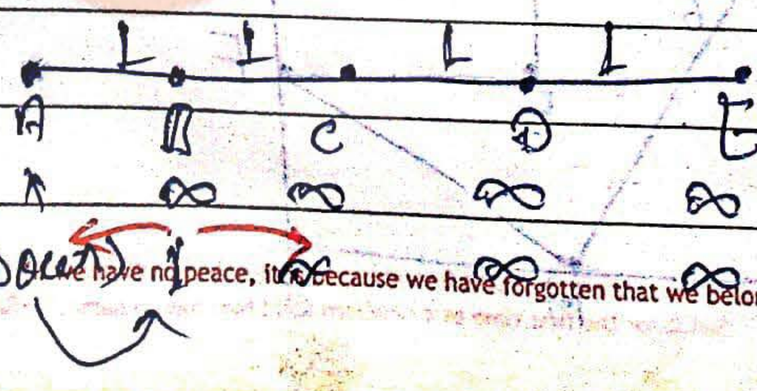
A	8
B	20
C	28

min(8, 10+24, 6+21, 12+20)

min(

Drawback:

1) Count to "∞" problem:



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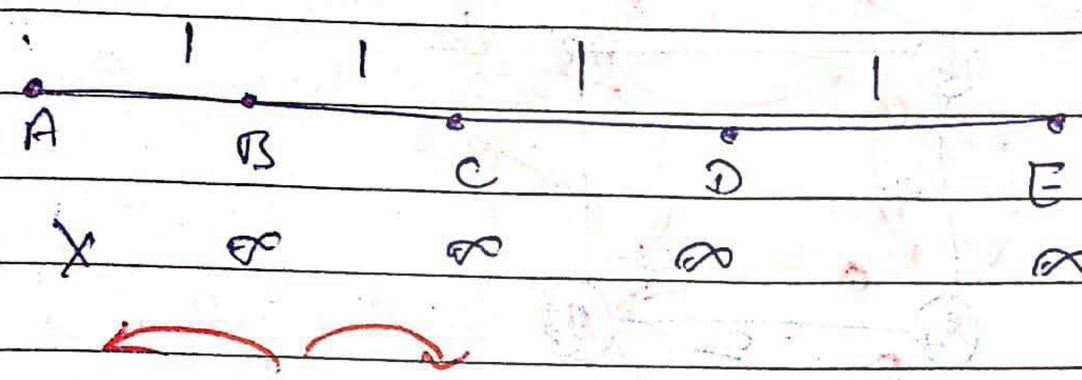
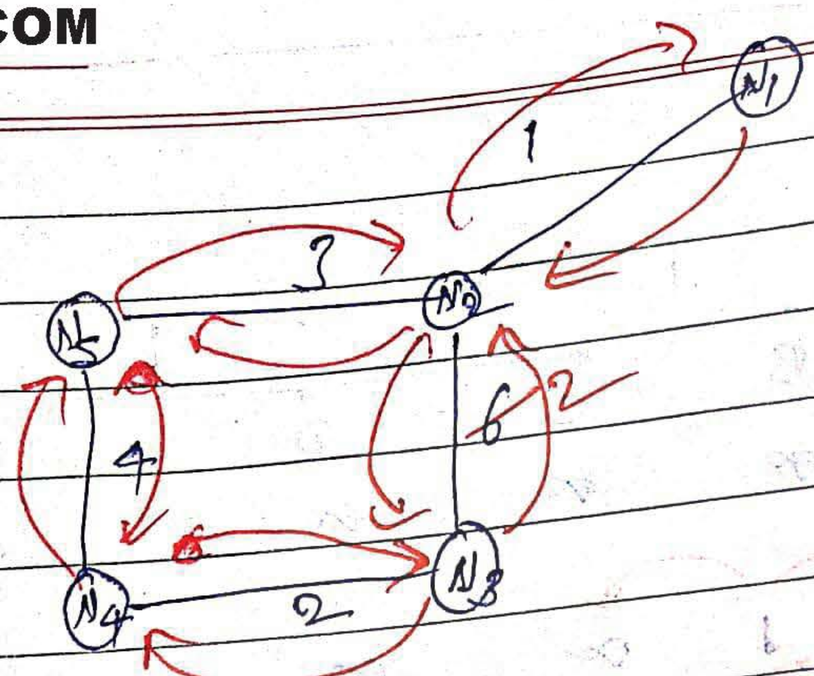
good



Q.7



The network uses a distance vector routing. Once the vect have stablised the distance vector at diff nodes are following. 07

	N_1	N_2	N_3	N_4	N_5
N_1	0	1	7	8	4
N_2	1	0	6	7	3
N_3	7	6	0	2	6
N_4	8	7	2	0	4
N_5	4	3	6	4	0

80/7

50/4

each distance vector is the distance of the best known path at that instance to nodes, N_1 to N_5. where the distance to itself is zero, also all links are symmetric and the cost is identical in both direction. In each round all nodes exchange their distance vector with their respective neighbour's. Then all nodes update their distance vectors in b/w two round any change in the cost of a link will cause the two incident nodes to change only that entry in their distance vector.

The cost of link N_2 to N_3 reduces to 2 in both direction, after the next round

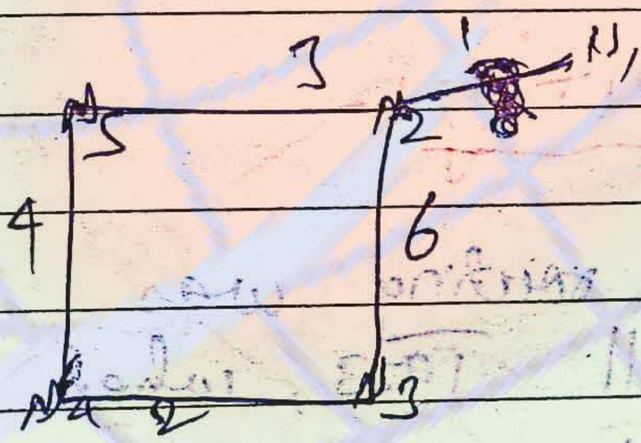
of update, what will be the new distance vector at node N_3.

Sol/

N_3 (3, 2, 0, 2, 5)

Q/ After the updates in the previous question the link N_1 to N_2 goes down, N_2 will reflect this change immediately in it's distance vector as cost "∞", after the next round of update, what will be the cost of N_1 in distance vector N_3.

Sol/



N_1 (0, 1, 7, 8, 4)

N_2 (1, 0, 2, 4, 3)

N_3 (3, 2, 0, 2, 5)

N_4 (5, 4, 7, 2, 0, 4)

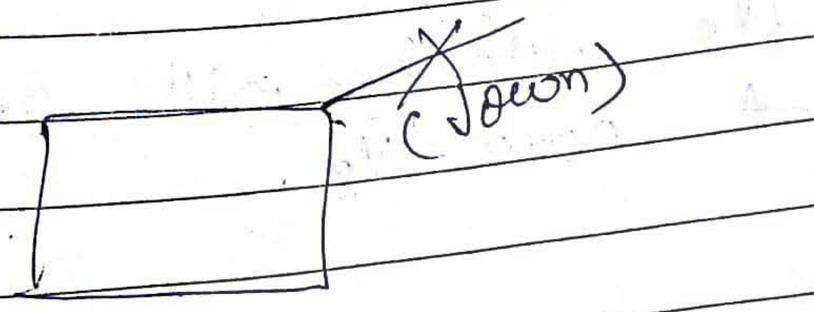
N_1 (0, ∞, 7, 8, 4)

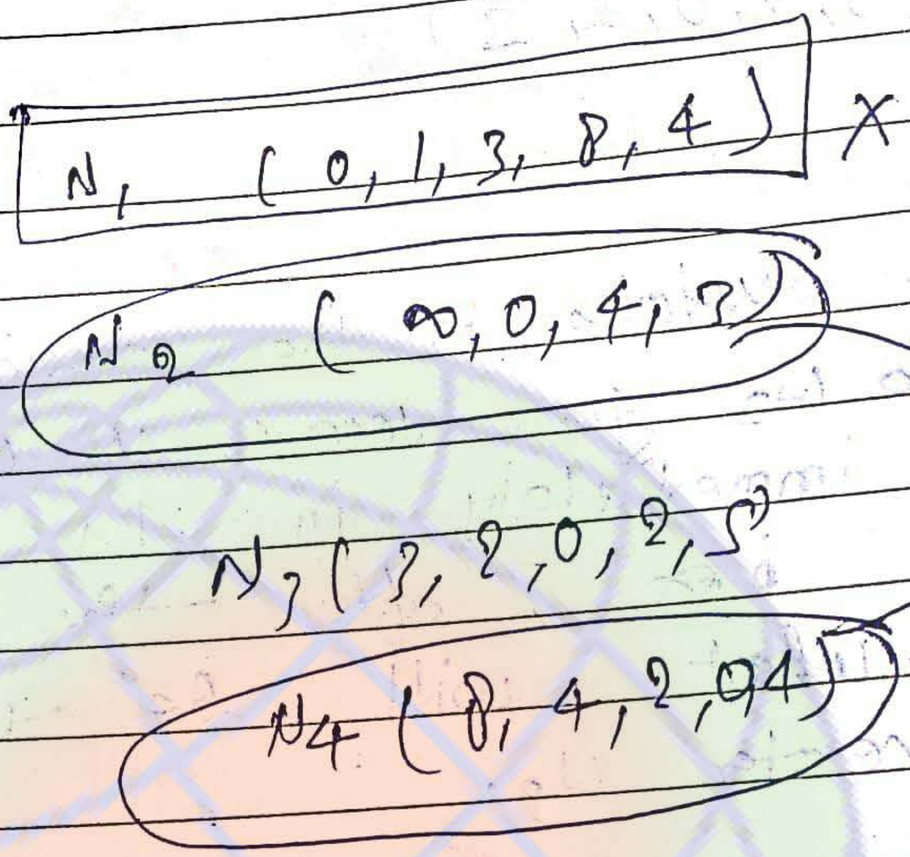
N_1 (0, 1, 7, 8, 4)

N_2 (1, 0, 2, 4, 3)

N_4 (8, 4, 2, 0, 4)

N_5 (4, 3, 5, 4, 0)





✱ Link state routing :-

Distance vector routing was used in ARPANET till 1979, when it was replaces by link state routing.

Two primary problem cause it's demise :-

(a) since the delay matrix was queue length it did not take line bandwidth into account when choosing route.

(b) Count to infinity problem.

- Key the idea behind the link state routing, can be stated as five parts :-

(a) Discover its their neighbour and learn their network address.

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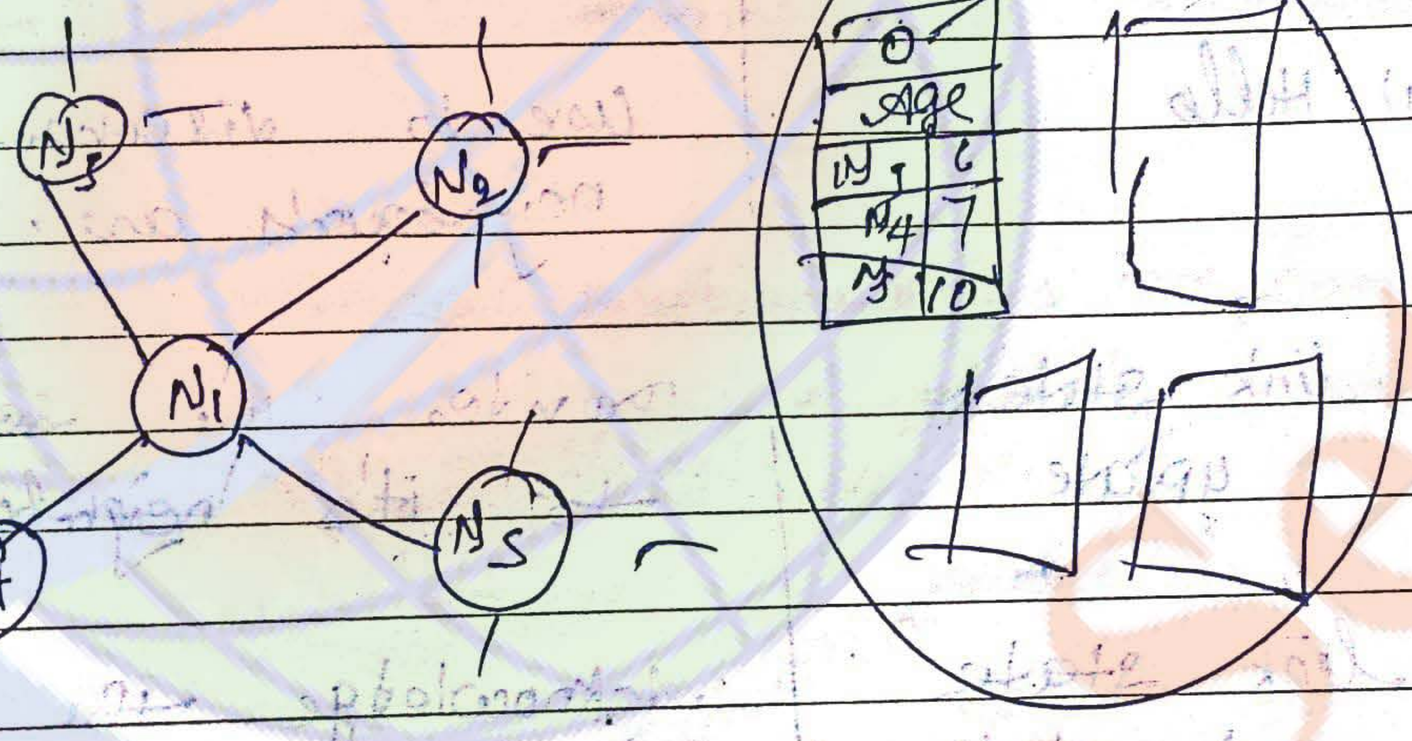
(b) Major the delay or cost to each of it's neighbour.

(c) Construct a packet telling all it has just learn

(d) Send this packet to all other routers.

(e) Compute the shortest path to every other router.



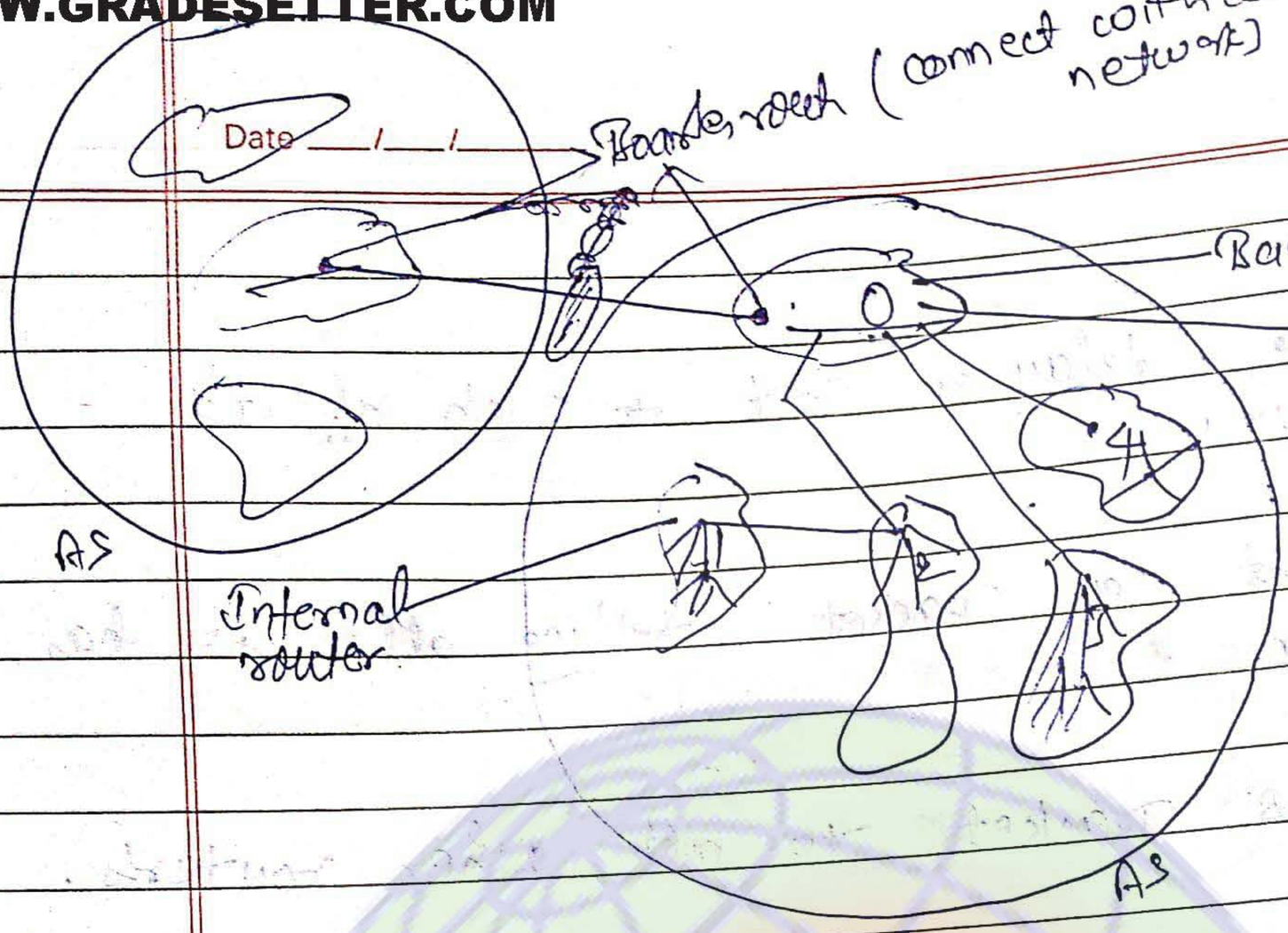
★ OSPF (Open shortest Path first) :-

It's an interior gateway routing protocol.

- Intra - within → OSPF
- Inter - BGP → Border gateway Protocol → exterior

AS - Autonomous system

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore



message type:-	Description :-
(a) Hello	use to discover who the neighbour's are.
(b) link state update	provides the sender cost to it's neighbour.
(c) link state acknowledgement	Acknowledge the link state update.

In 1988, the internet engineering task force begin work on sucessor of orginal Internet a interior gateway protocol which was a distance vector protocol based on balman ford algorithm.
The sucessor called OSPF, became standard in 1990. OSPF support three kind of connection in network :-
(a) Point to Point lines b/w exactly two routers

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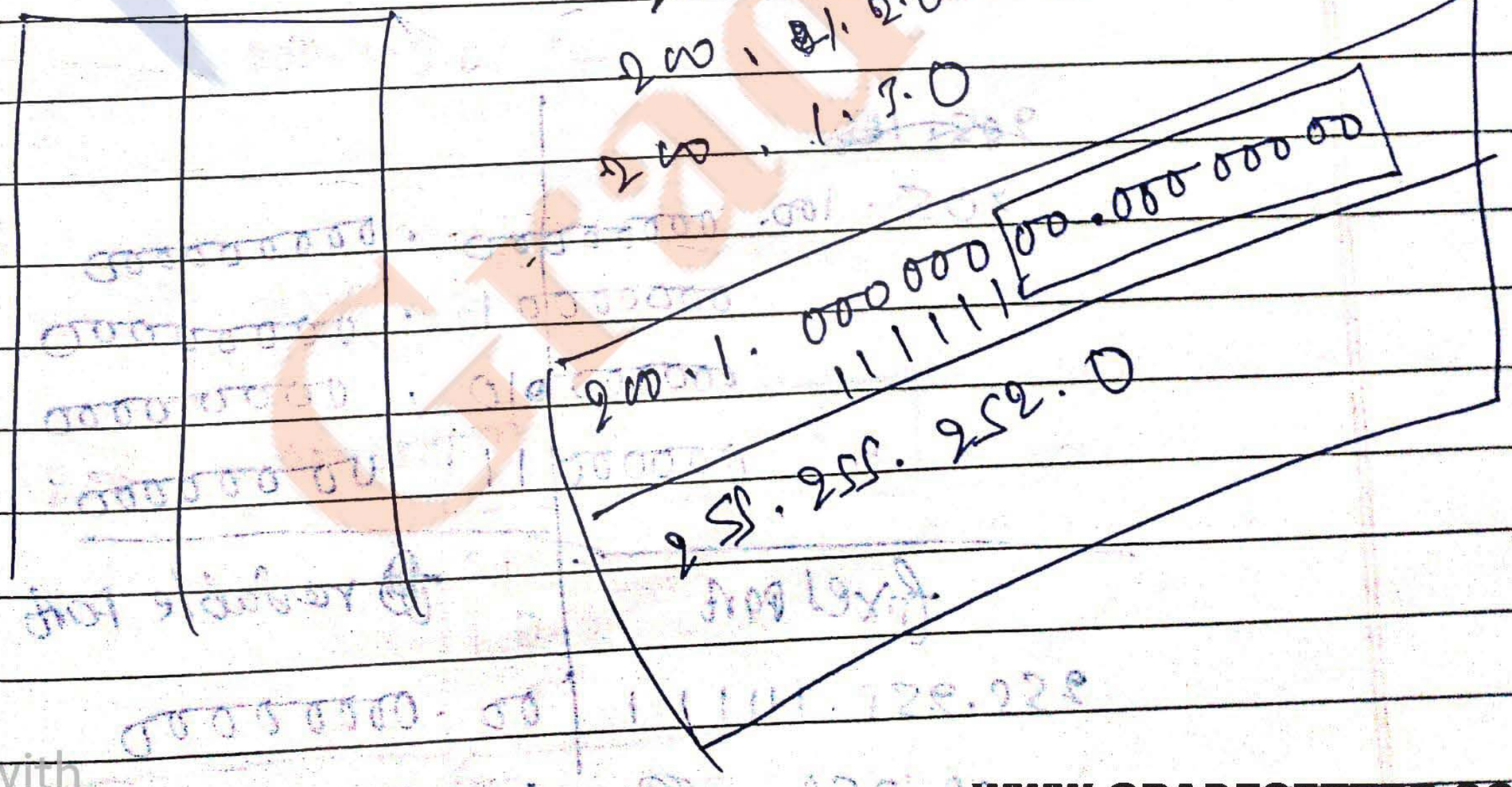
(b) multi access networks with broadcasting
(c) multiaccess networks without broadcasting

A multiaccess network is one that can have multiple routers on it and each of which can directly communicate with all others.

☆ Super-netting :- (Useful)

The process of aggregating two or more networks to generate a single network is supernetting.

Restriction in supernetting :-
(i) All the network must belongs to same class.
(ii) The network id of the network must be in sequential order or contigious.
(iii)



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Subnet mask :

It is uses to generate single IP address to a group of network based on two rules :-

(i) The no. of 1's indicate fixed part.
(ii) No. of 0's indicate variable part.

Q) Perform a CIDR aggregation on the following IP address and generate a single IP address

205.100.0.0
205.100.1.0
205.100.2.0
205.100.3.0

Subnet mask = ?
Subnet id = ?
~~Subnet~~ direct broadcast :- ?

80/1

~~255.255.255.0~~

~~205.100.~~.
205.100.00000000.00000000
00000001.00000000
00000010.00000000
00000011.00000000

fixed part | variable part

255.255.111111 | 00.00000000

255.255.252.0

64
16
96
0

eg

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= 255.100.00000011.1111111

255.100.7.255

Q) 200.96.86.0
200.96.87.0
200.96.88.0
200.96.89.0

Ans 200.96.

64-32 16 8 4 2 1
× × × ×

64
32
16
96
0

eg. 200.0.1.0 200.1.0.0/24
200.1.1.0/24
200.1.2.0/24
200.1.3.0/24

→ $4 \times 2^8 = 2^{10}$

200.1.000000 00.00000000
01
10
11
200.1.000000 00.00000000

"Do not say, 'It is morning,' and dismiss it with a name of yesterday.
See it for the first time as a newborn child that has no name." —Rabindranath Tagore

Counter Strike

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(1)

↳ studies in Responsibilities of network layer :-

- Routing
- filtering & forwarding
- checksum

Transport layer:-

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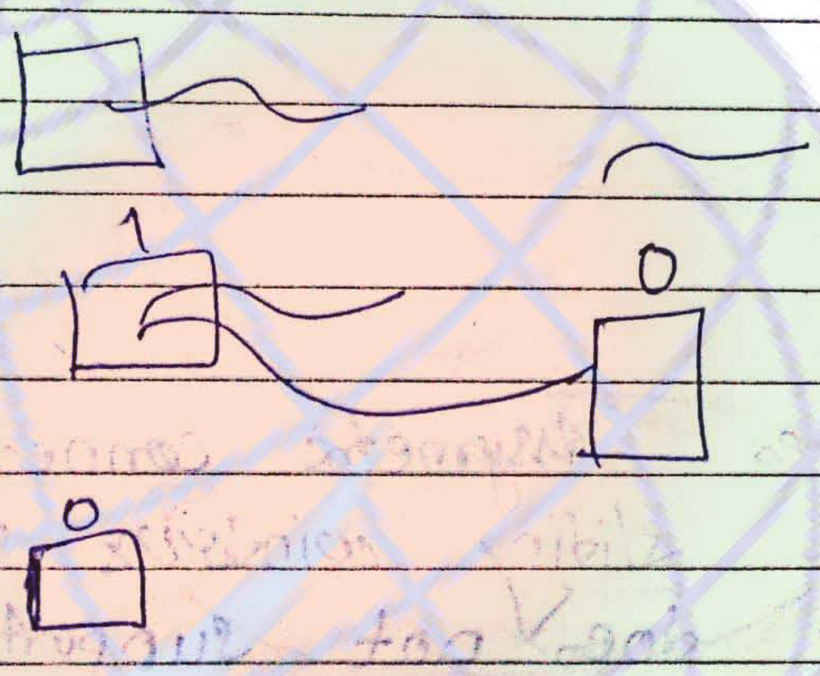
Transport layer Protocol

(1) TCP (Transaction control protocol):-

(A) 1092

(B) 1092

192.156.72.98: 1092



* TCP/IP:-

Shocket's are going to identify the connection.

* TCP characteristics
  (i) It is a reliable byte stream oriented port to port transport layer protocol.

  (ii) TCP is using selective repeat and having the acknowledgement.

  (iii) TCP is using Accumulator acknowledgement Principle.

  (iv) TCP connections are full duplex connection.

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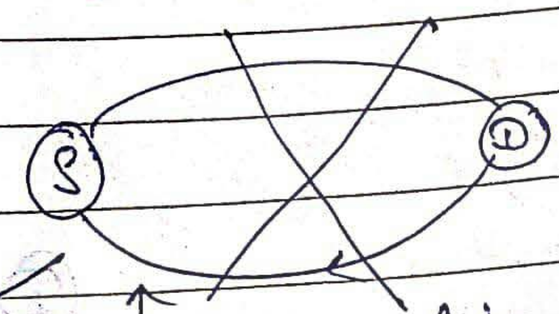
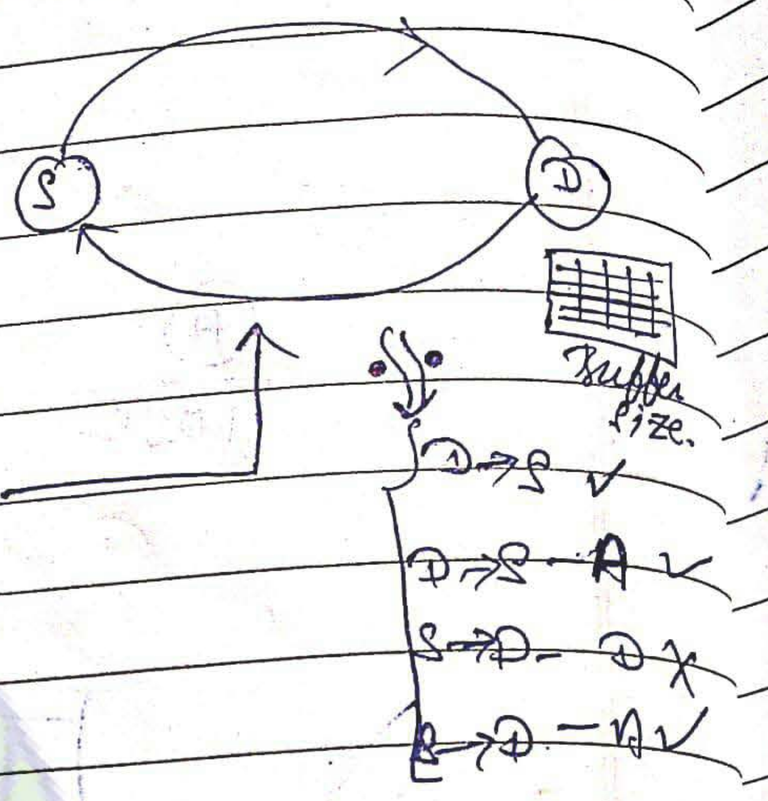
(V)

Connection:-



Symmetric connection
Asymetric connection

If one Connection is terminated then whole connection will terminate.



(VI) TCP uses Assymetric connection

(VII) TCP uses sliding windows Protocol.

(VIII) TCP does not support broadcast and multicasting.

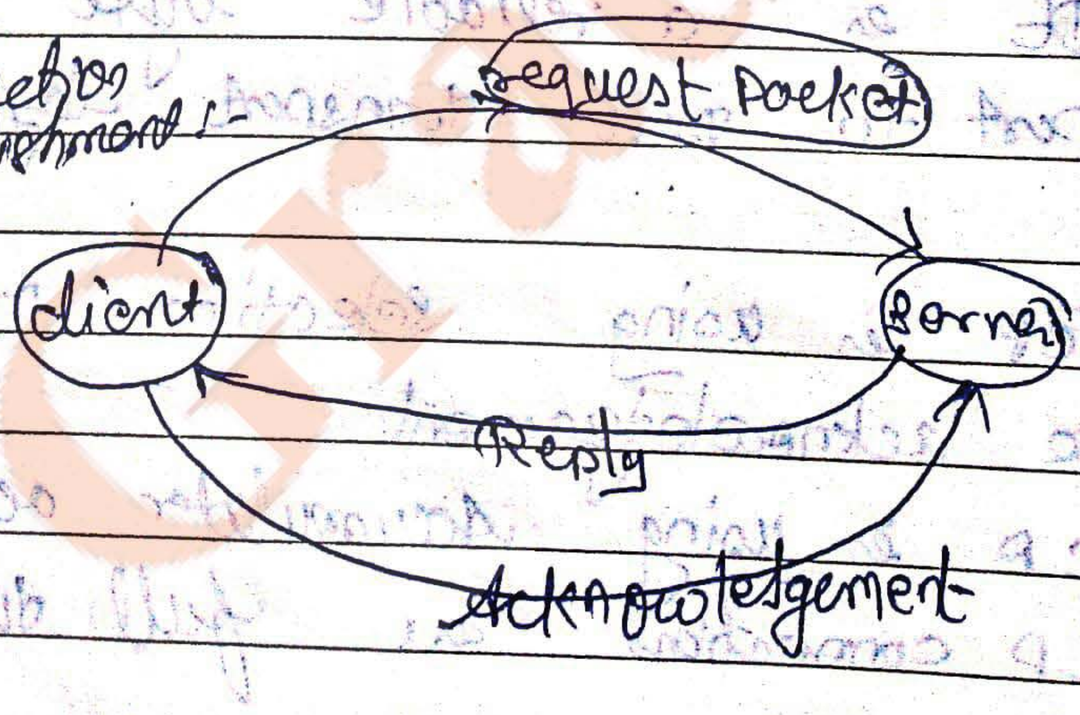
* Phases of TCP Connection:-

(i) Connection establishment

(ii) Data transfer

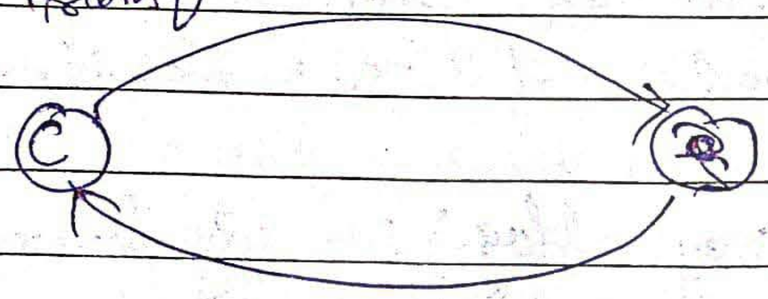
(iii) Connection termination.

(i) Connection Establishment:-



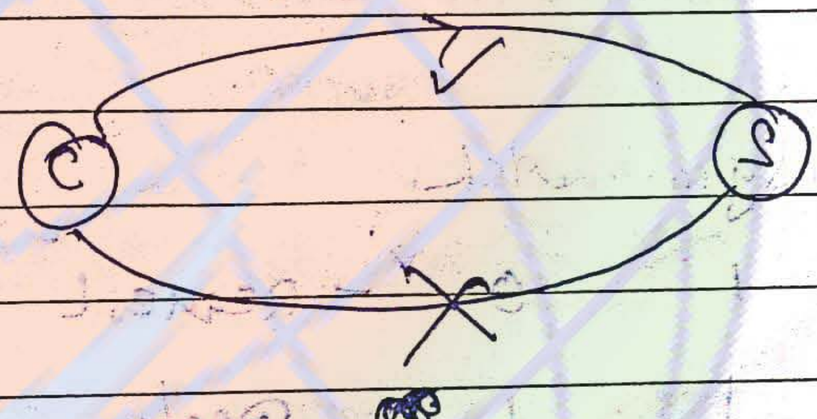
"If we have no peace, it is because we have forgotten that we belong to each other." —Mother Teresa

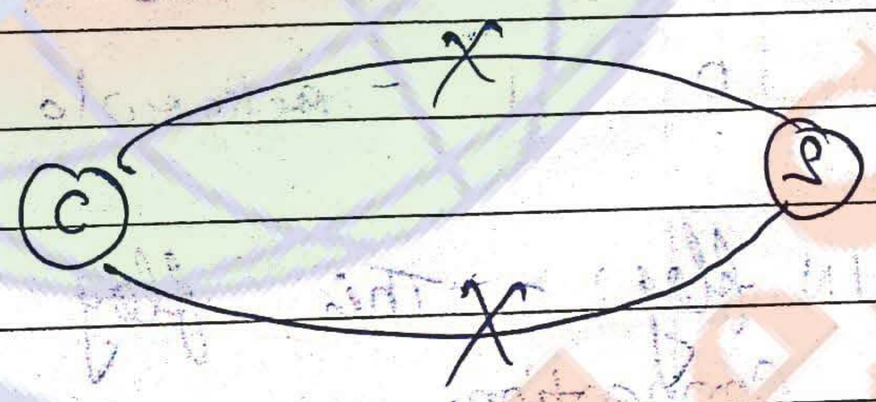
(11) Data transfer:-



(111) Connection termination:-

or





* TCP header:-

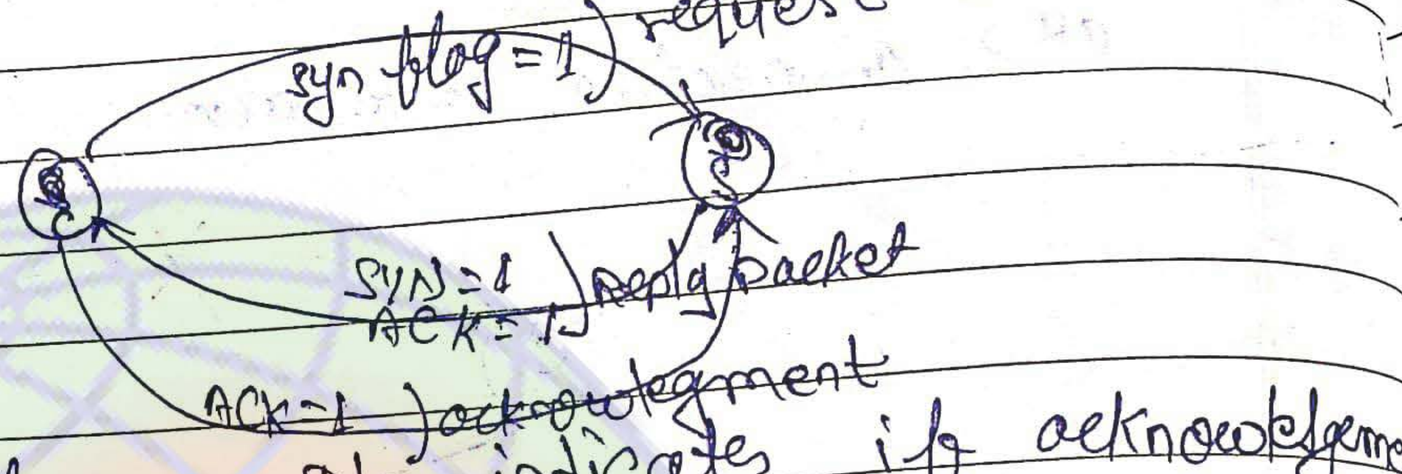
TCP header,

31		16
SP (Source Port)	16	DP (Destination Port)
Seq no.		32
Ack no.		32
TCP header 4	6 bit	2 3 4 5 6 6 bit
Checksum		URG PTR
Option		

Advertisement window

(i) Each no. in header fields represents 4 byte word of TCP header.

(a) SYN (syn flag) :- Synchronisation flag used for connection establishment.



(b) ACK flags :- It indicates if acknowledgement is 1, and it contain data and acknowledgement

Sym Ack

1 0 - Request

1 1 - Reply

0 1 - acknowle (Data + acknow only acknow)

(c) FIN flag :- This flag is used to terminate the connection.

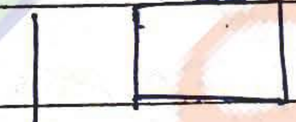
(d) RST flag :- (Reset flag) :- It is used to refresh the connection.

(e) URG flag (urgent flag) :- If urgent flag is set at transport layer, then network layer will increase the priority.

(f) PSH flag (~~Post~~ Push flag) :- when a packet with PSH = 1, if it is available at TCP, it must push it to the upper layer without waiting to 50 miliseconds.

(ii) whenever ~~silly~~ sillywindow syndrom, whenever there is 1 byte of data is exchange b/w sender and receiver then it is sillywindow syndrom during sillywindow syndrome efficiency is zero.

Reason for silly window syndrom-
(a) whenever receiver announces it's window size as zero, when sender generates 1 byte of data, when consume 1 byte at a time



(iii) TCP uses a random initial sequence number to stop ~~in~~ segment from previously closes system to the accepted as a valid segment for this session.

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5.1
X

* Rap around time-

whenever we start with the sequence numb the time taken to reach the same sequence number is called rape around number.

Q) Consider the line bandwidth ei 40 mega bits per second and sequence number fiels consist of 32 bits. find out the rape around time for the sequence number.

3.3

[34

Sol)

~~8 mega bytes~~ =

40 mega bits per second

$\frac{40}{8}$ = 5 mBYte/sec

5 mega sequ no — 1 sec

1 — 4

$\frac{1}{5\times10^6}$

2^{32}

$= 2^{30} \times 2^2$

4G

4

40×10^6 / 8×10^6

800 sec Ans

Q) Consider a bandwidth of 4omega bits/sec and life period of 50sec. find the suitable no. of bits in sequence no. of fiell to handle the situation.

Page No.:

TCP, UDP and IP trade

3.1 a ✓
b ✓
(c) ✓
d ✗

(3.2) A –
P –
S – session
T → Transport layer provides end to end connectivity
N – Net
D –
P

↓ transport from end to end

3.3 255.255.31.0
class B – 0-127, 128, 192
a ✓
b ✗
c →
(c)
b ✓
(d) ✗

(3.4) Bridge → A
P
S
T – Transport layer
N – Router IP address
D – Bridge (mac address)
P

(3.5) e

24 – 3 : netco host in

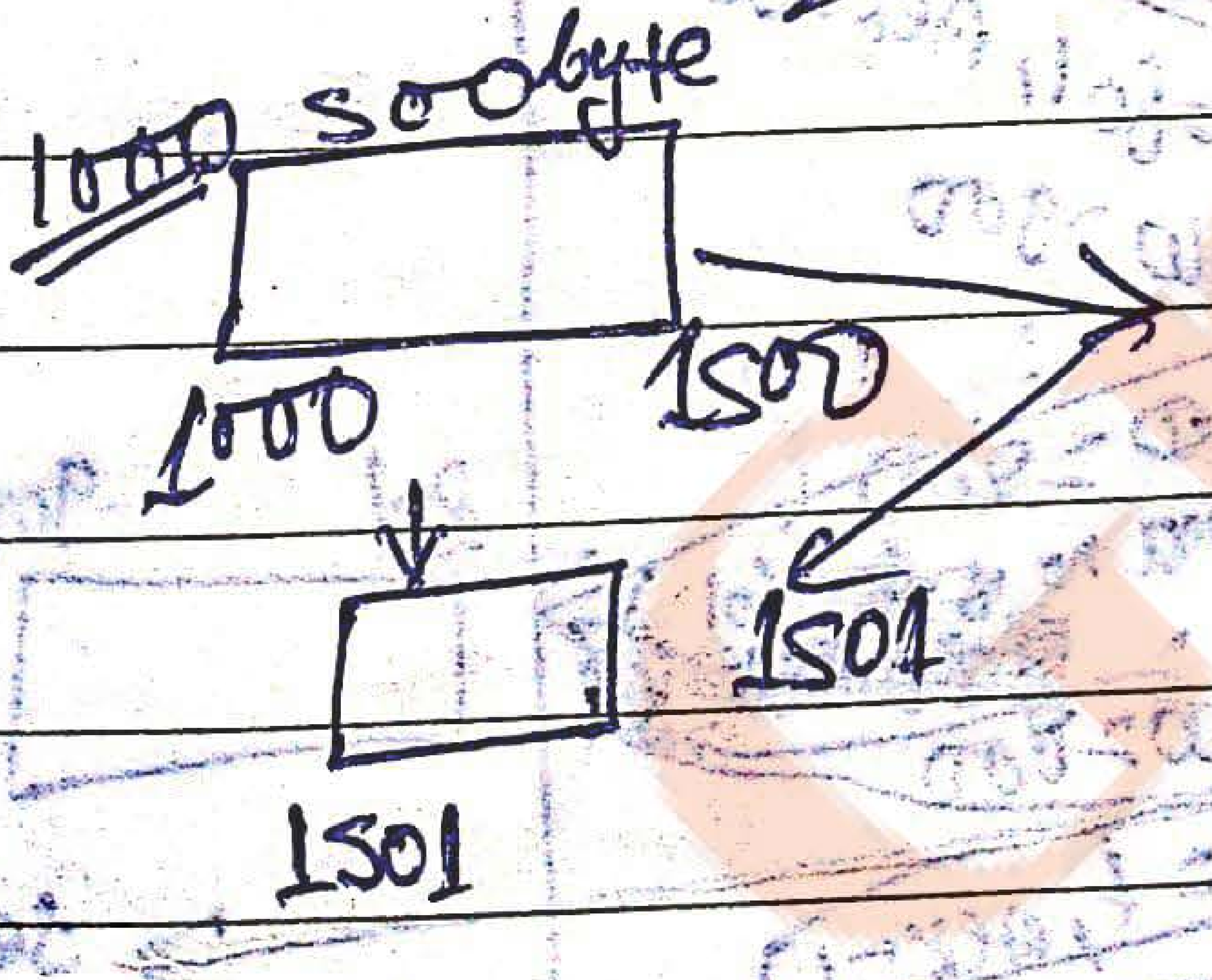
mega 10^6

30/4

bandwidth = 40 megabits / sec

4 = 5 mega byte

50 = 250 M / 2048 =



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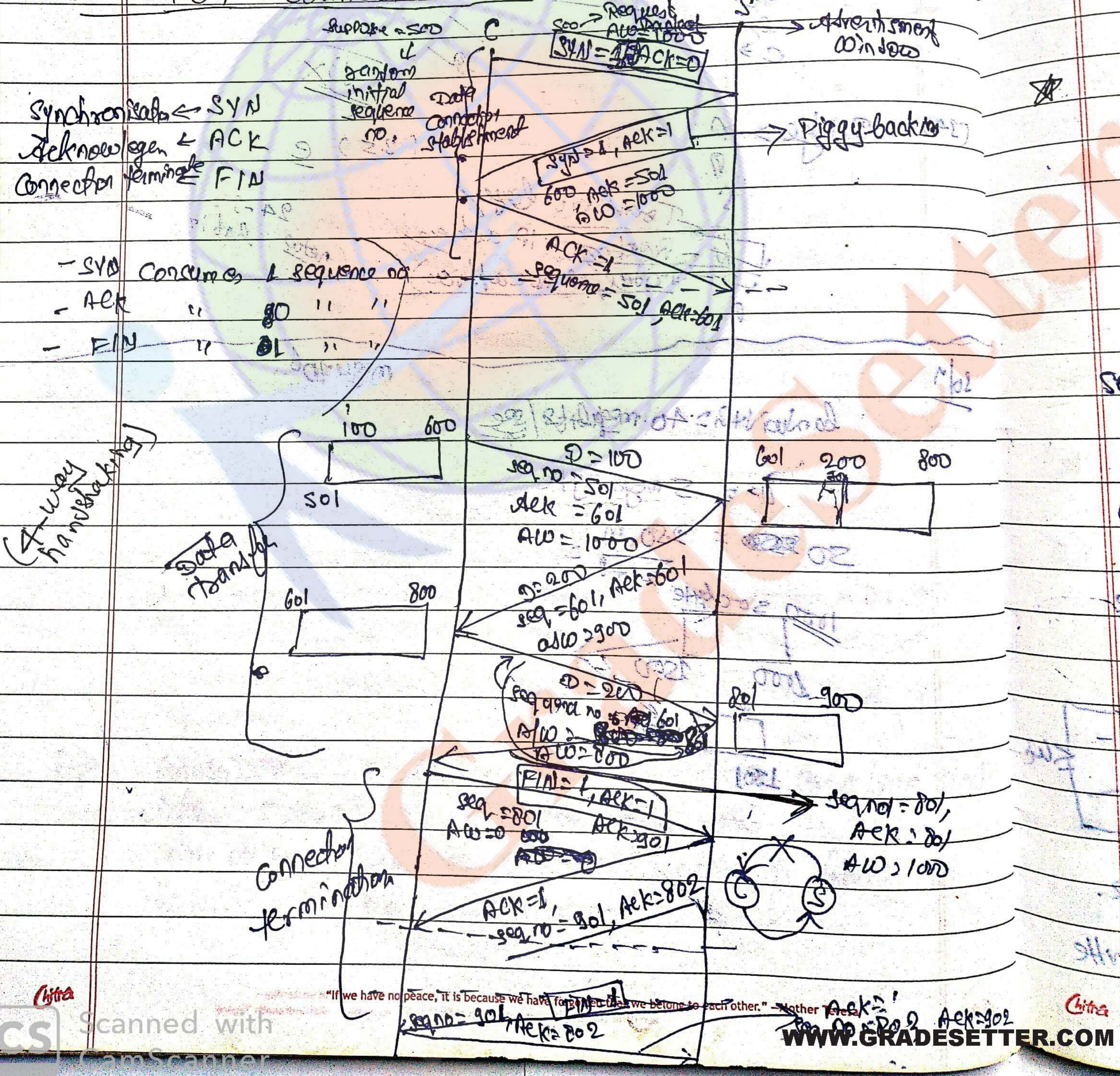
★ Urg Pointer:

It is used to indicate how much data in the packet is urgent. It is applicable when flag is equal to 1, otherwise it should be ignore.

★ TCP Connection Establishment:-



"If we have no peace, it is because we have forgotten that we belong to each other." – Mother Teresa

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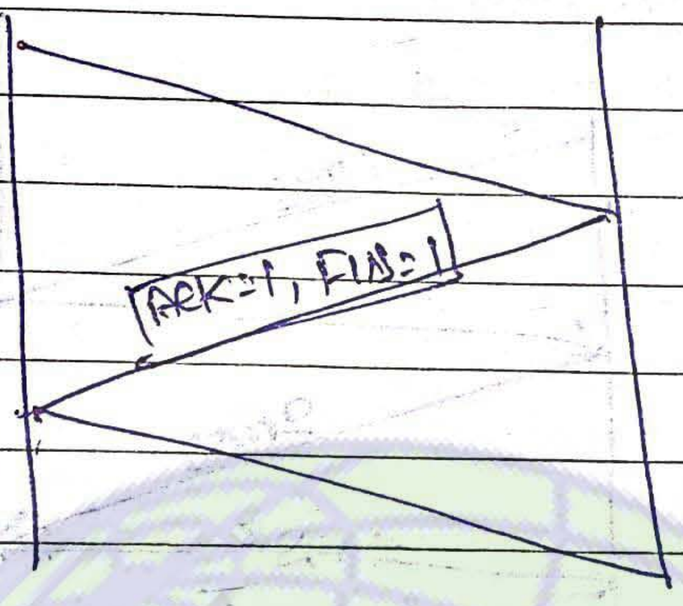
3 way handshaking



TCP Congestion Control-

TCP sender is having two windows one is sender windows (ws) and 2nd is congestion window (wc). ws will give you receiver capacity and wc will give you underline network capacity.

so sender will transmit minimum of sender window and congestion window.

- Estimation of sender window size:-
  It can not be statically determined so, we use advertisment windows dynamically.

- Estimation of Congestion window size.
  There is no static method which means we have to go for AIMD algorithm.
  ↳ Additive increase and multiplicative decrease.

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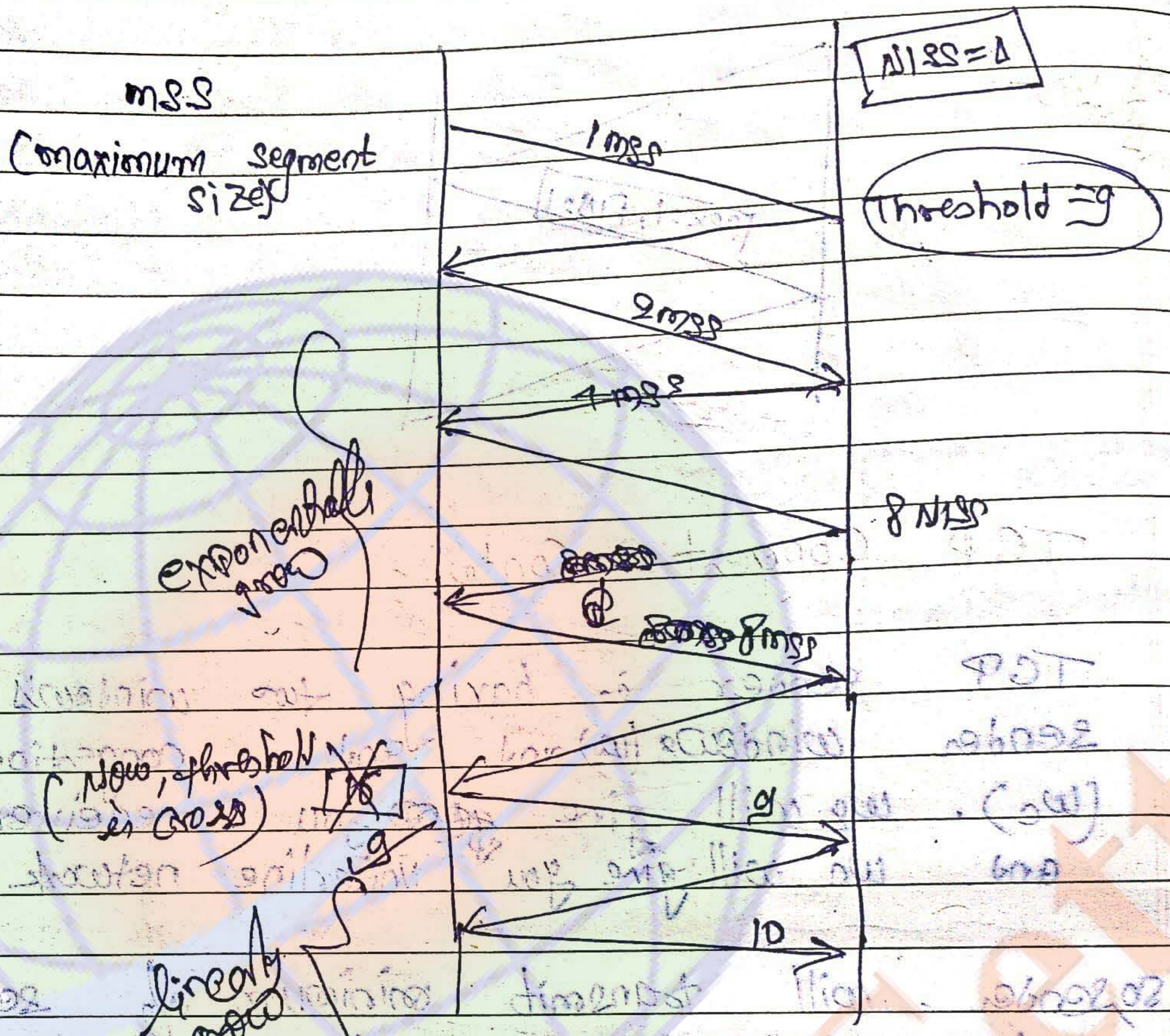
✱ Slow start Phase:-



✱ How does sender perceive Congestion?

(i) loss event:- Time out or 3 duplicate acknowledgement.

(ii) Sender's limit transmission = last byte sent - last byte ack

should be less than equal to congestion window.

$T_p = \frac{\min(w_c, w_s)}{R+T}$ = rate at transmitte the data.

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- After 3-duplicate acknowledgement the congestion window cut in half and window then grow linearly.

But after time out event congestion window set to 1mss (maximum segment size), window then grows exponentially to a threshold, then grows linearly.

→ 3 duplicate ack. indicates network capable of delivering some segments. but timeouts indicates a more alarming congestion scenario.

* Congestion avoidance: -

* 3-duplicate packet: -

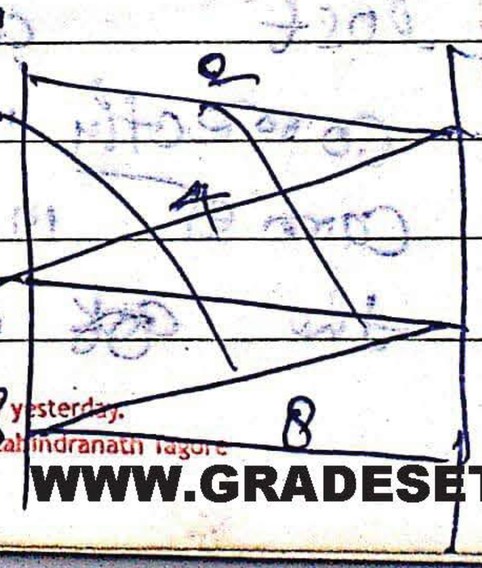
* Time-out: -

a) Consider an instance of TCP AIMD algorithm where window size at the start of slow start phase is 2mss and the threshold at the start of first transmission is 8mss. Assume that a time out occurs during 5th transmission. find the congestion window size at the end of 10th transmission.

Soln

2, 4, 8, 9, 10, 11, 12,

threshold 8



Ans = 12

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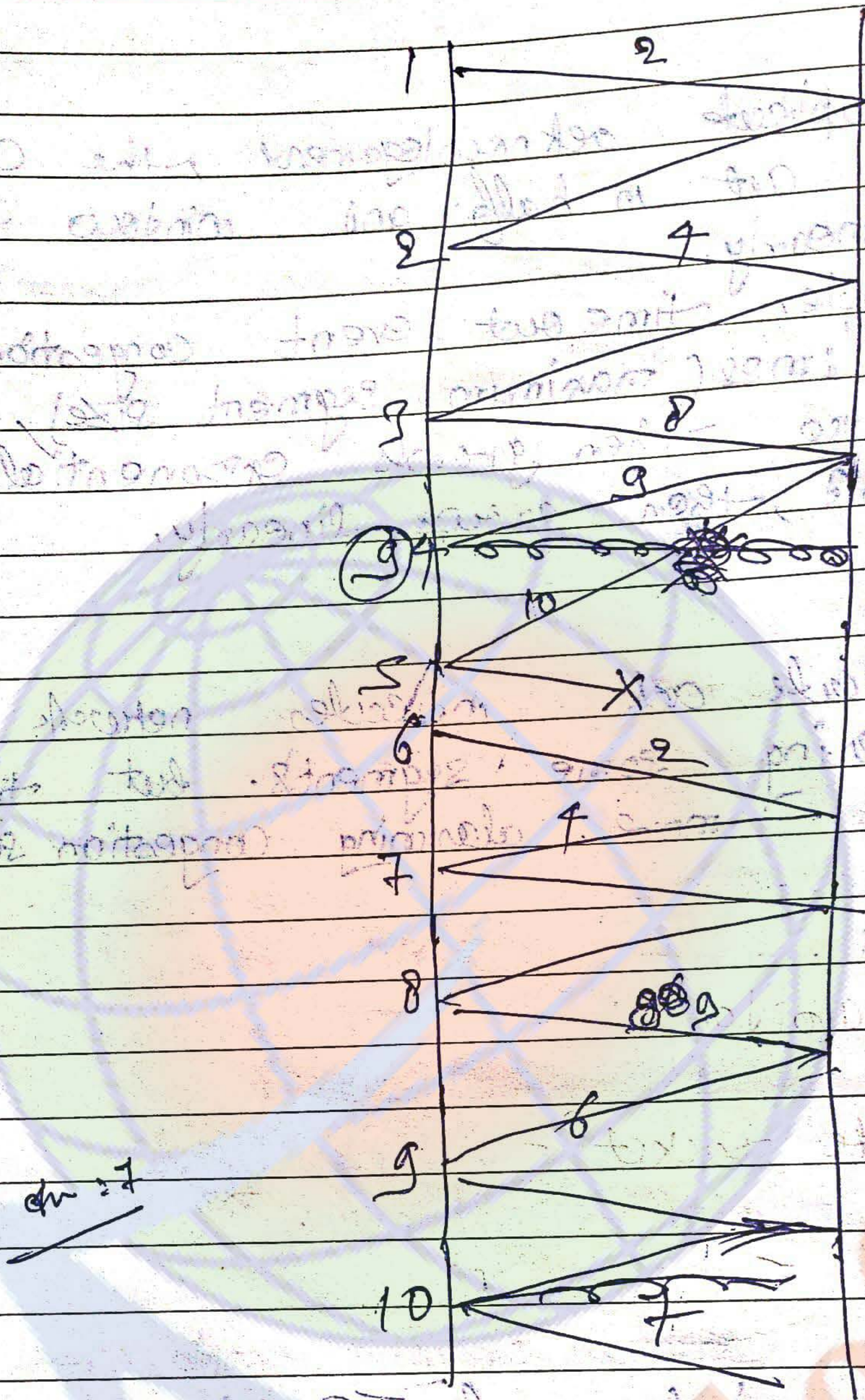
Soln



Soln

S46 (3.19)

Soln

Q.) Consider a TCP connection in state where there are no outstanding acknowledgement. The sender sends two segment back to back, the sequence no. of 1st and 2nd segments are 230 and 290 resp. The 1st segment was lost and 2nd segment was received correctly. Let x be the amount of data carried in the 1st segment in byte. Wht 'x' be the ack no. by the receiver. The

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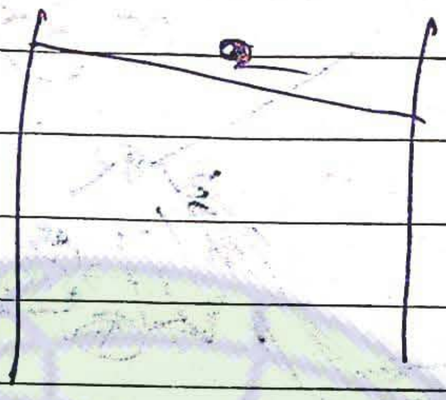
value of x and y are in order

Soln



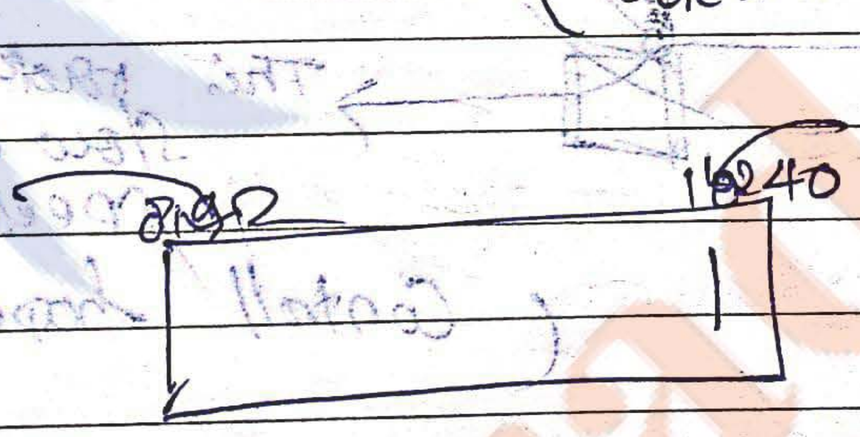
S46 (3.19) On a TCP connection current congestion window size is 4 kilobyte. The window size advertised by the receiver is advertisement window equal to 6 kilobite. The last byte sent by the sender is 10240 and the last byte acknowledges by the receiver is 8192. Current window size at the sender.

(a) 2048 (b) 4096 (c) 6144 (d) 8192

Soln

CWC = 4 kilobyte
ACW = 6 kilobyte

last byte sent = 10240
ack = 8192



Last byte - first byte ≤ congestion window

10240 - 8192 = 2048

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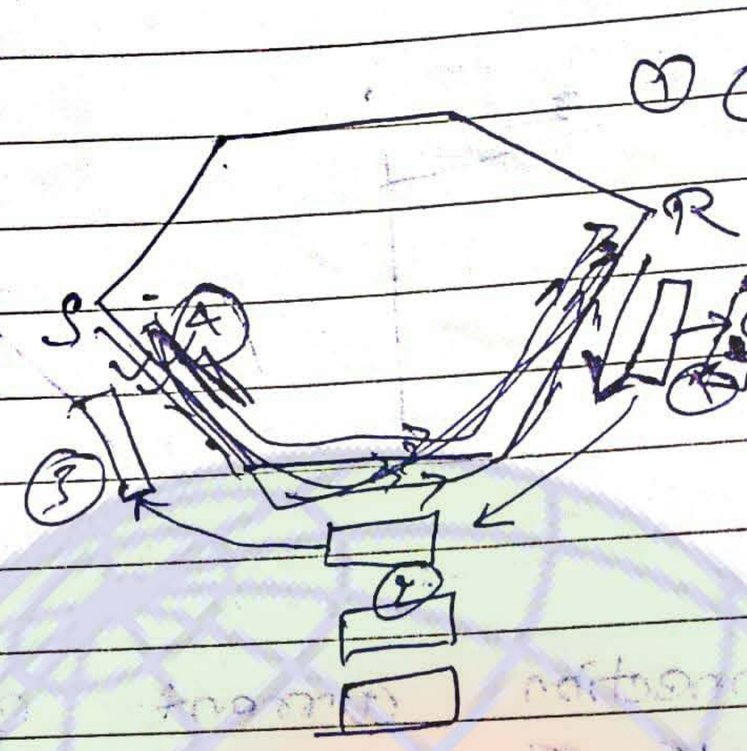
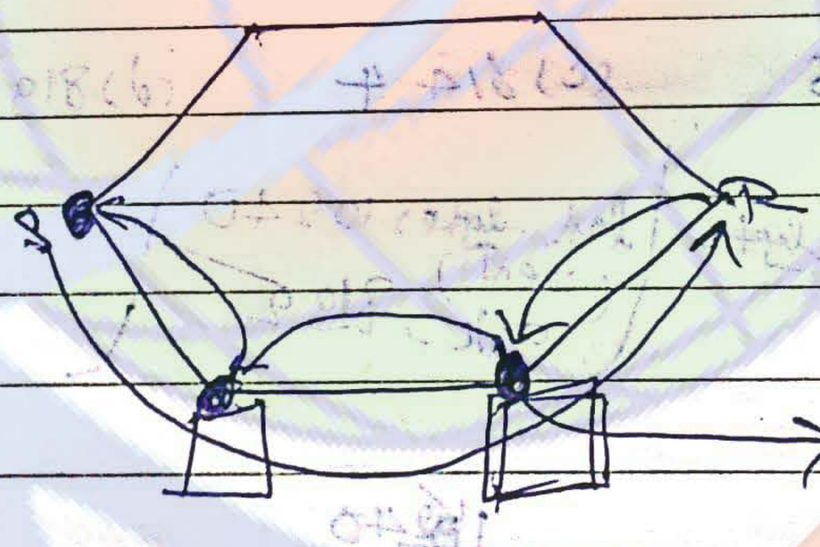
Choke Packet! -


1
2
3
R
S
A
B
F

"Choke Packet"
↳ Reverse direction (Inform the sender to slow down the speed)

~~Hope Case~~

Hope Packet:-

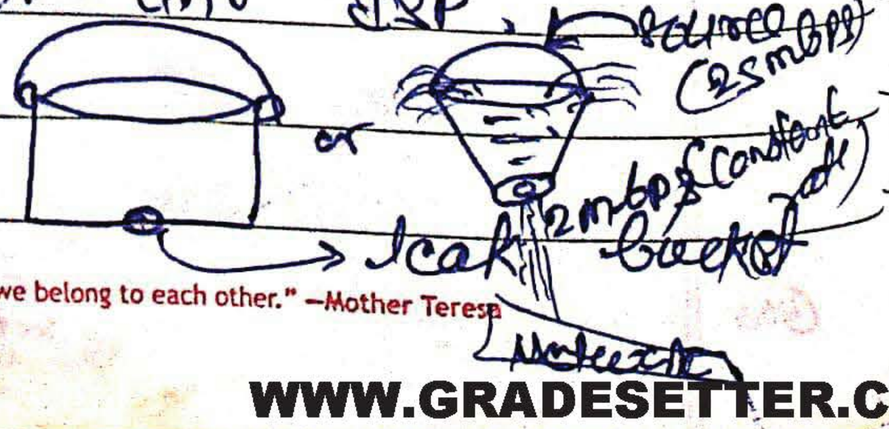


This packet will slow down the speed.
(Control hope by hope)

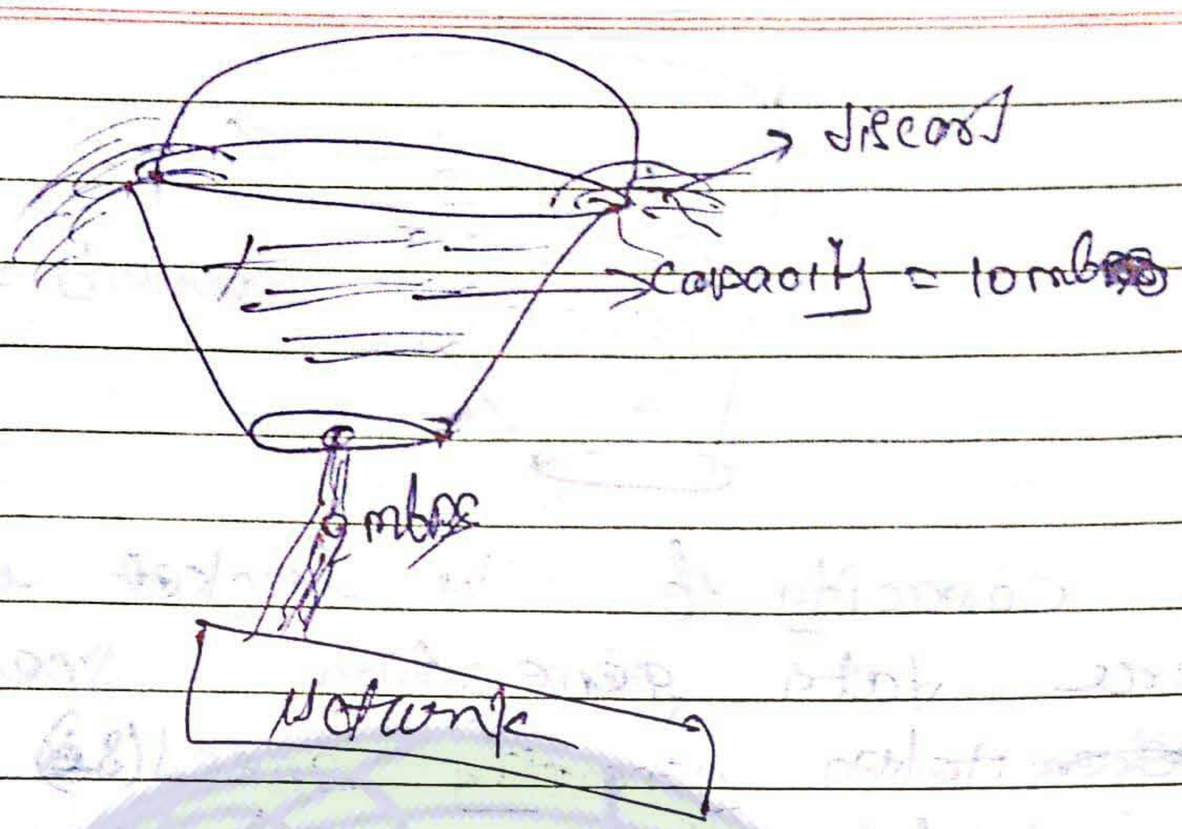
Quality of Service! -

1.) Traffic shaping! - There should be agreement b/w user and ISP.

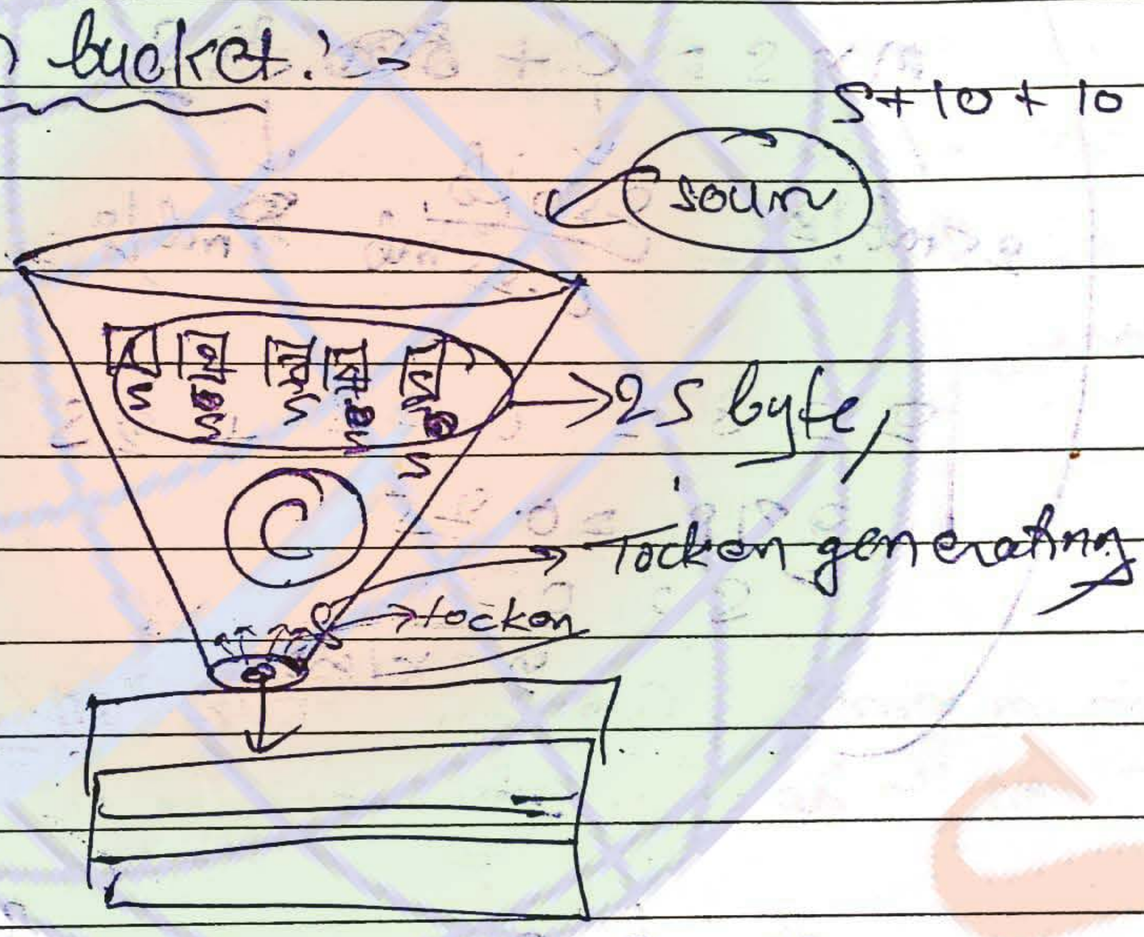
↳ leaky bucket! -



"If we have no peace, it is because we have forgotten that we belong to each other." —Mother Teresa



↳ Token bucket:-



M → rate at which the source is generating the data

S → is the burst time. / Total time that the sance will transmite the data,

C → capacity of bucket

$m \times S = C + \rho \times S$

ρ → Token generating speed.

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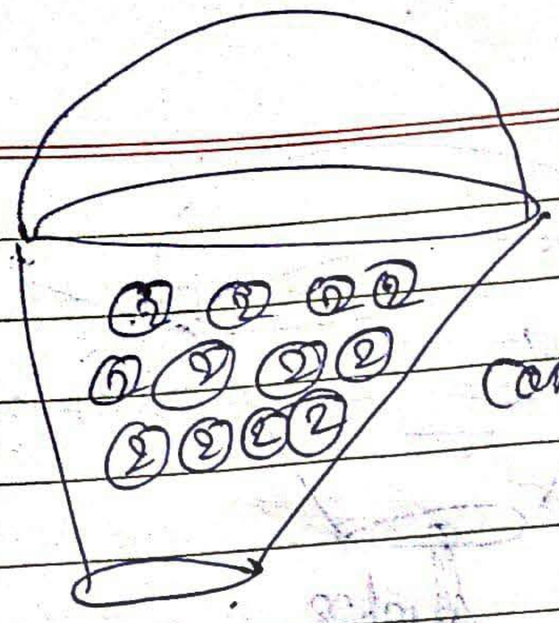

capacity = 40mbite

eg.) If capacity of the bucket is ~~200kb~~ 250kb source data generation speed is 25 mb/s. ~~token~~ token generating speed(s) is 2mb/s calculate the s.

Soln

$$m \times s = C + f \times s$$

25mb/s, 250kb = 0.25mb, 2mb/s

$$25s = 0.25 + 2s$$

$$23s = 0.25$$

$$s = \frac{0.25}{25 \times 10^6}$$

$$25 \times 10^6 \times s = 250 \times 10^3 + 2 \times 10^6 \times s$$

$$\left(25 \times 10^6 - 2 \times 10^6\right) = 250 \times 10^3$$

$$23 \times 10^6 \times s = 250 \times 10^3$$

$$s = \frac{200 \times 10^3}{23}$$

$$= 10.9 \text{ msec}$$

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TCP Timer management:-

Timer for it's operation :-
(i) Acknowledgement timer:-
(ii) Keep alive timer's
(iii) Persistance timers
(iv) Timed and wait timers.

(ii) Keep alive timers:-

It is used to keep track of ideal TCP connections. If there is no communication for a Pre-defined period of time, the connection will be closed automatically.
eg. netbanking time

(iii) Persistance timers:-

It is used in silli window syndrom to transfer silli packets in equal interval of time. This decided by Percistance timer's.
eg. ATM regularly sends the packet.

(i) Acknowledgement timer:-

We Cant determine round trip time statically as we did in data link layer. So we need dynamic methods.

A Basic algorithm:-

Let's assume initial round trip time (IRTT) is equal to 50 sec. Smoothing factor is equal to 0.9 ($0 < \alpha < 1$)

"Do not say, 'It is morning,' and dismiss it with a name of yesterday.
See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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new round trip time (NRTT) is equal to 70sec.
find the estimated roundtrip time.

Estimated round trip time (ERTT) = $\alpha \times$ ERTT $+ (1-\alpha)$ NRTT

So [NRTT = 50sec
smoothing factor > 0.9 ($0 < \alpha < 1$)
NRTT = 70sec

ERTT $= 0.9 \times 50 + (1-0.9) \times 70$
$= 52$ sec

Time out $= 52 \times 2$
$= 104$ sec

Now, assume:-
New round trip time = 80 sec
then ERTT = ? → Now this estimate become initial,

ERTT $= 0.9 \times 52 + (1-0.9)\ 80$
$= 54 \times 8$

Time out $= 54 \times 8 \times 2$
$= 1096$

Note:- The default time out of basic algorithm is twice of estimated round trip time.

Linux Tunnel → through access, Proxy server, VPN - Configure

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* Jacobson's Algo!-

This algo says that instead of multiplying roundtrip time with 2, you can take standard deviation to calculate the time out.

$$SD = |DRTT - NRTT|$$

SD → Standard deviation

Q) If IRTT = 50 sec, and NRTT = 70 sec, Find SD = ?, $\alpha = 0.9$, let D_i = initial deviation = 5 sec

Sol:

$$ERTT = 0.9 \times 50 + (1 - 0.9) \times 70$$
$$= 52 \text{ sec}$$

$$D_N = SD = |50 - 70|$$
$$= 20 \text{ milliseconds}$$

D_N ← New deviation.

$$D_E = \alpha \times D_i + (1 - \alpha) D_N$$
$$= 0.9 \times 5 + (1 - 0.9) 20$$

D_E → estimated deviation

estimated deviation = 4.5 + 2
= 7.5

$$T_O = ERTT + 4 \times D_E$$

T_O → Time out

D_E → Estimated deviation

$$= 52 + 4 \times 7.5$$
$$= 52 + 30.0$$
$$= 82$$

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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KARN'S Algorithm

If time out occurs because of delayed acknowledgement, the data packet is re-transmitted. Then there is a possibility of two acknowledgements -

(i) The delayed acknow. of 1st packet
(ii) Acknowledgement for retransmitted packet

Then it causes ambiguity that which ack. must be taken into consideration for the next transmission. So, this ambiguity is resolve by karn's algo which says that.

Don't update the roundtrip time for any segment which is re-transmitted but just double the amount for each failure until segments get through

UDP

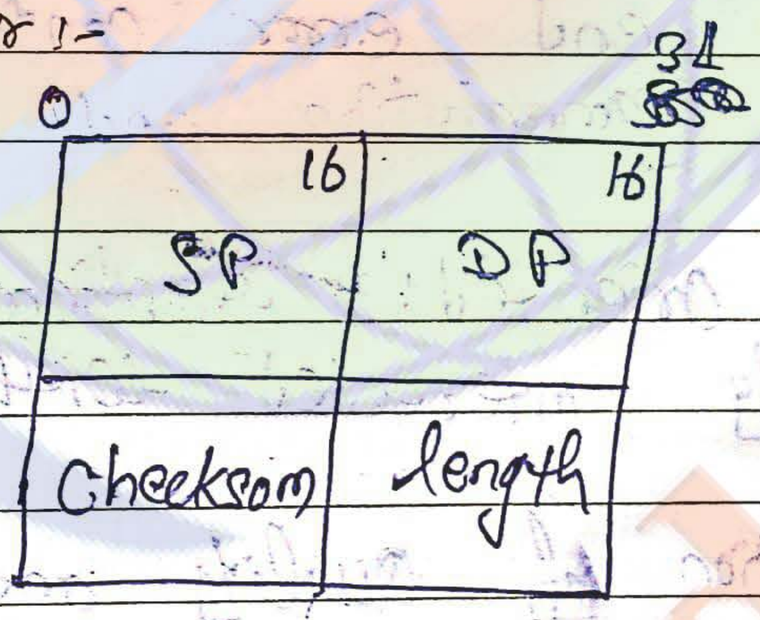
(i) It is connection less protocol. It is used for multicasting and broadcasting application

(ii) for real time application, TCP is not applicable because of congestion window - that why UDP is used, It does not have congestion window.

(iii) For multimedia application TCP is not used because of congestion window.

(iv) Some application requires fastness rather than reliability. so TCP can't be used.
eg. DNS,

★ UDP header :-



★ The difference b/w UDP and TCP

TCP	UDP
(i) Connection oriented, reliable, slow	(i) connection less, non-reliable and fast
(ii) overhead is high due to header and connection	(ii) overhead is low

"Do not say, 'It is morning,' and dismiss it with a name of yesterday.
See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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(iii) HTTPS, FTP, Telnet, remote login, SMTP, these all are using the application of TCP.

(iv) Web application, mail file transfe, remote system administration they all uses TCP

(iii) DNS, SNMP (Simple network management protocol), RIP, all multimedia Protocols uses UDP.

(iv) name translation, real time, multi broad casting, multicasting and network management. These all done by UDP.

* Responsibility of transport layer Protocol:-

(i) End to end error control, flow control, and segmentation and re-assembly.

(ii) User Oriented:- Application Programmer can directly interected with ∞

(iii) Negotiation of quality and type of service

(iv) It also deals with storage capacity of the subnet and congestion control.

* (v) multiplexing and demultiplexing

(vi) Service port addressing or Socket addressing.

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* Responsibilities of session layer:-

(i) Dialog or control or desciplne management
↓
connection
managent

(ii) Sesion layer send's some dummy packet to the Server to keep connection alive

(iii) maintaining synchronisation or check points.

(iv) maintaining the group of operation.

A
SO

A = A - SO

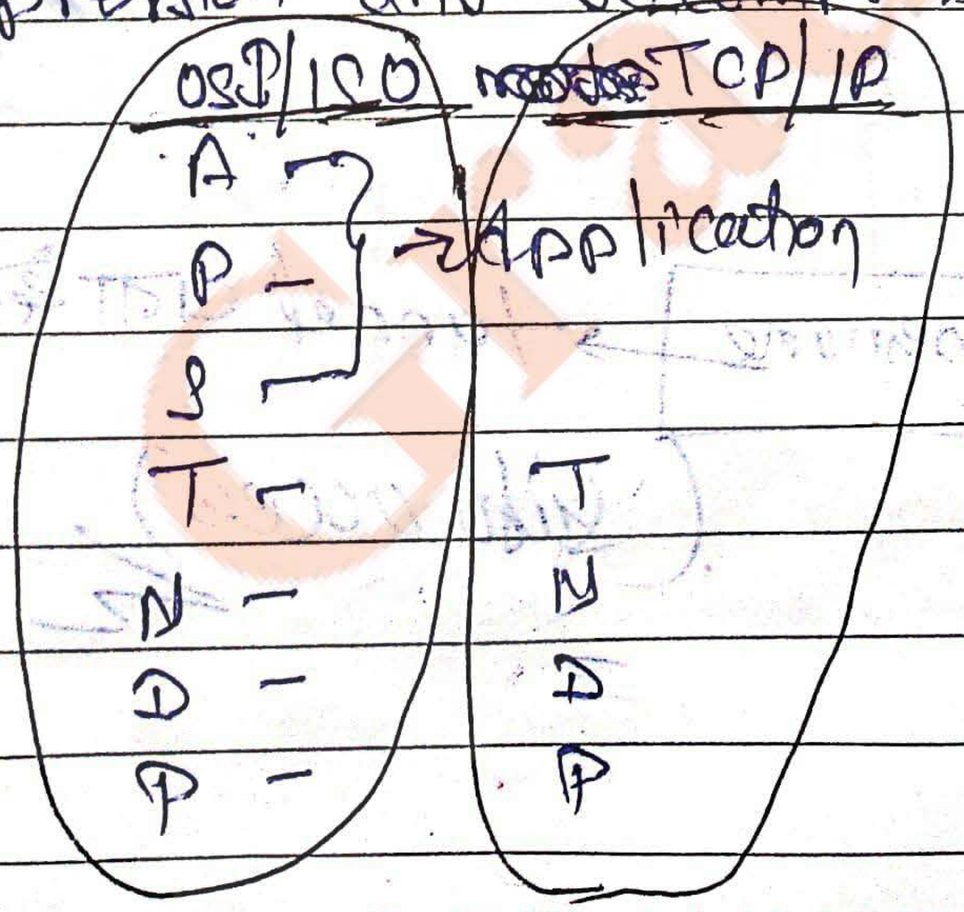
B
O

B = B + SO

→ Atomic operation

* Responsibilty of Presentation layer

(i) encoding and decoding
(ii) encription & Decription
(iii) Compression and decompression.



"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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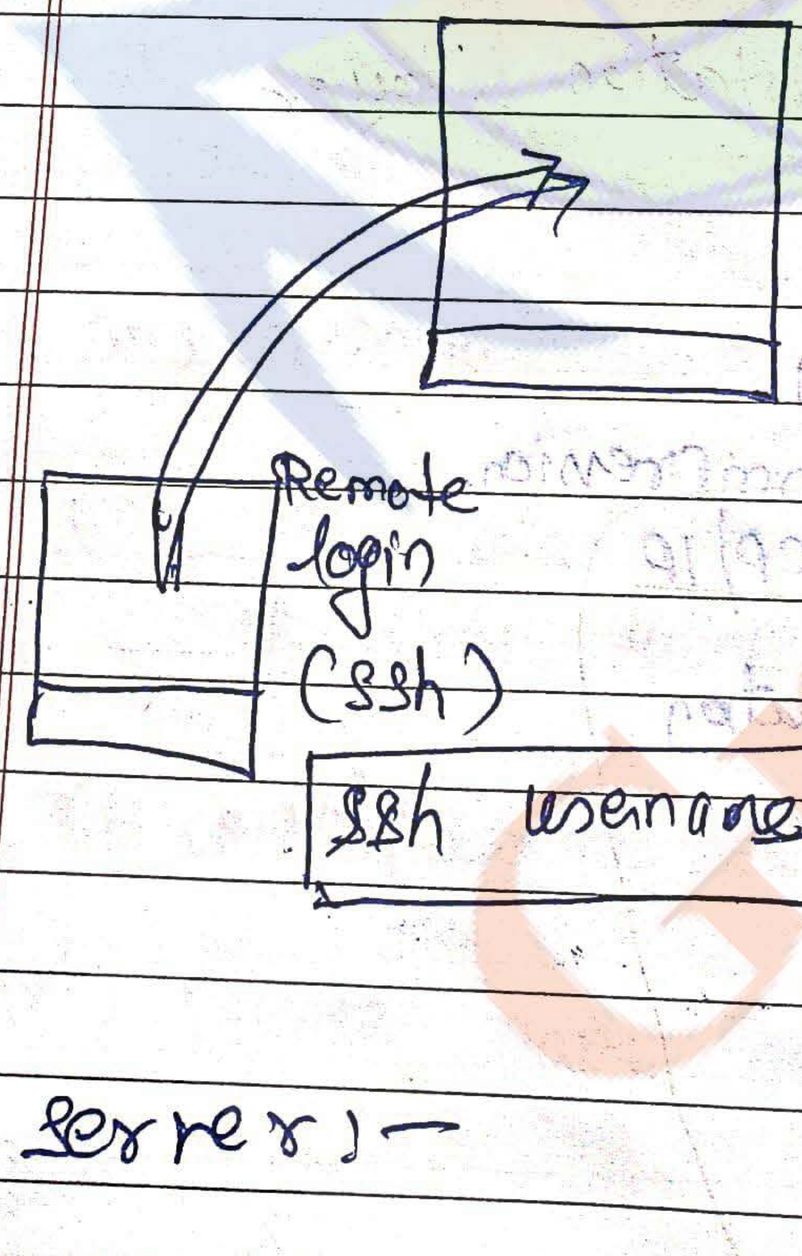
Application layer

The protocols available. This layer allows users to directly communicate with the application.

Protocols of application layer :-

(i) SMTP
(ii) Telnet
(iii) FTP
(iv) TFTP
(v) HTTP
(vi) HTTPS etc

Telnet :-



Server :-

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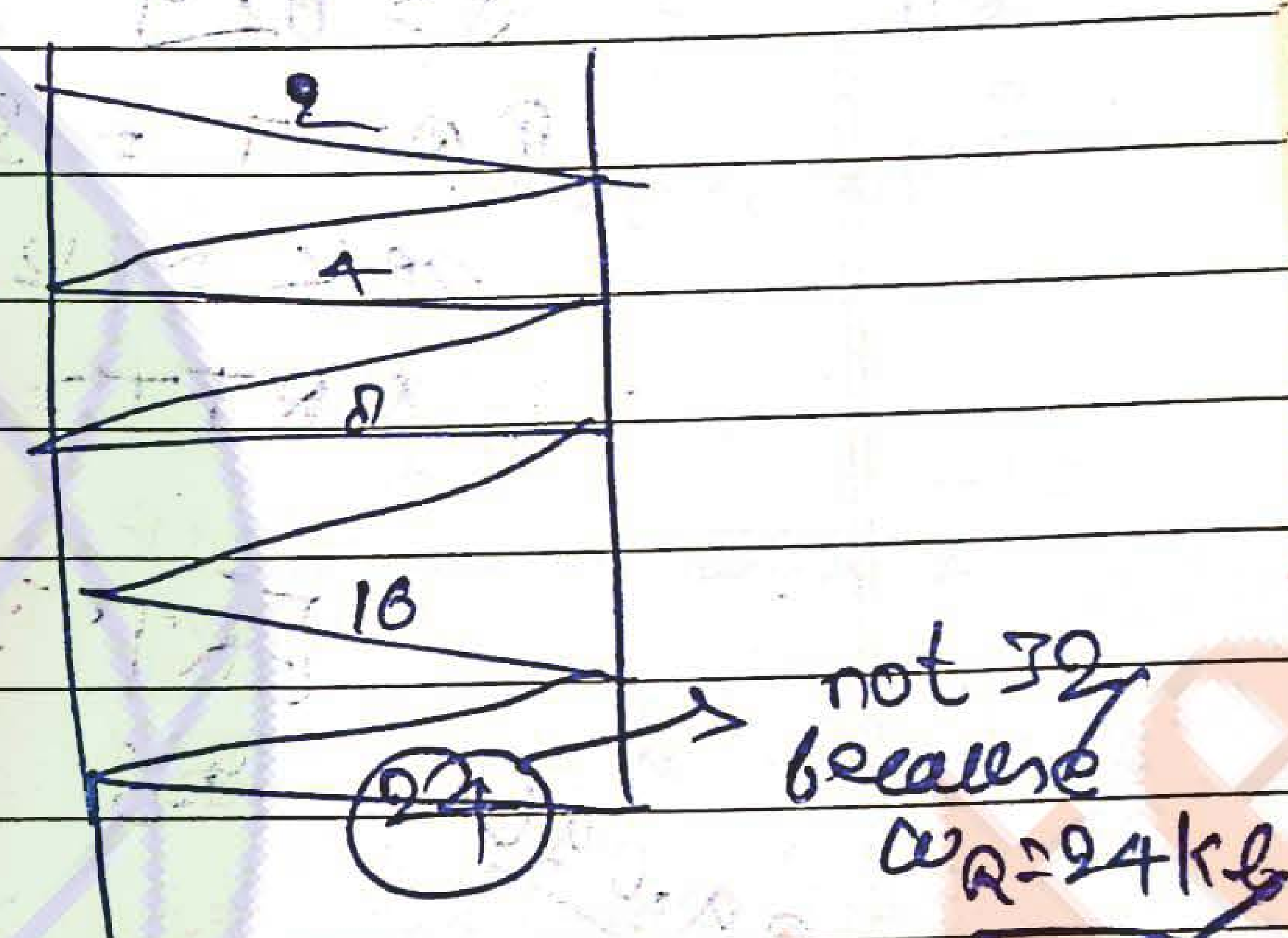
Q. ~~SPDTPOST~~

Q) Consider the affect of slow start on a line with 10 milisecond RTT, and no congestion the receiver windows size is 24 kb and maximum segment size is 2kb. how long does it take before the 1st full window can be sent.

So/- RTT = 10 milisecond

w_R = 24 kb

max. seg size = 2 kb



Q) suppose the TCP congestion window is 18 kb, and then time out occur's. then how big will be the congestion window, of the next 4 transmission's burst. assume that the maximum segment size is 1 kb.

So/- Congestion window size = 18

Now, time out

So, threshold = $\frac{18}{2}$ = 9

Ans ⇒ 8//

4
2
4
8

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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Q) If the TCP roundtrip time is currently 30 milisec, and the following ack. comes in after 26, 32, 24 milisec. What is the new roundtrip time estimated.

Using Smoothing factor is 0.9

$\delta = 0.9$

$RTT = 30$ milisec

ack = 26, 32, 24 milisec.

$NRTT = ?$

$ERTT = \alpha \times RTT + (1-\alpha) NRTT$

$= 0.9 \times 30 + (1-0.9) NRTT$

$= 26.0 + 0.1 \times 26$

$= 29.6$

$ERTT = 0.9 \times 29.6 + 1 \times 32$

$= 29.84$

$ERTT = 0.9 \times 29.84 + 1 \times 24$

=

Q) A TCP machine sending windows of 65535 bytes. over a 1 Gbps channel that has 1 way delay of 10 milisecond what is the maximum throughput achivable

and what is efficiency.

Sol'n

$W_s = 65535$ bytes

Throughput $= \frac{L}{RTT}$ — L = length of block, RTT = Round trip time

$= \frac{2^{16} \times 10^3}{20 \times 10^{-3}} = \frac{2^{16} \times 100}{10^{-2}} = 50 \times 2^{16}$

Throughput $= 50 \times 2^{16}$

$= 50 \times 2^{10} \times 2^6$

$= 50 \times 64 \times 10^7$

$=$

Efficiency $= \frac{\text{Throughput}}{\text{Bandwidth}} = \frac{50 \times 2^{16}}{2^{30}} = 50 \times 2^{-14}$

Q) The packet source can which of the following functionality must be implemented by transport layer protocol over and above the network layer protocol.

(a) recovery from pack loss
(b) detection of duplicate packets
(c) Packet delay in
(d) end-to-end connectivity.

Q) ~~which of the following~~ The routing table of a router is given below

Destination	Subnet mask	Interface
128.75.43.0	255.255.255.0	ethernet zero
128.75.43.0	255.255.255.128	ethernet one
192.12.75.5	255.255.255.125	ethernet 2
Default	0.0.0.0	ethernet 3

"Do not say, 'it is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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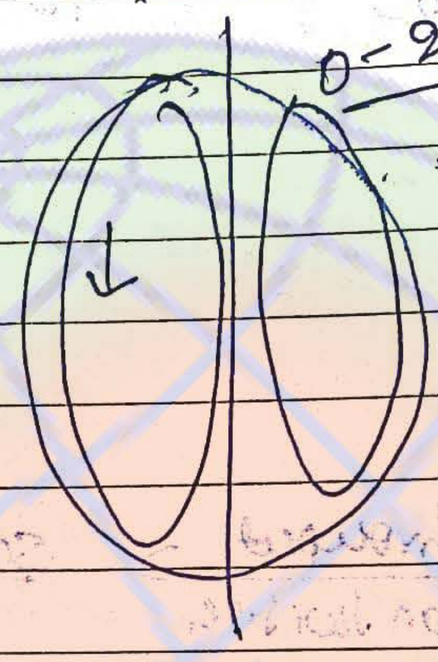
On which of the interface will the router forward the packet address it to destination 128.75.43.16 and 192.12.17.09

Sol'n



Sol'n

Net id

1

128.75.43.16 = ~~ethernet~~

IP →

128.75.45.10

255.255.255.0

AND

Net. adr.

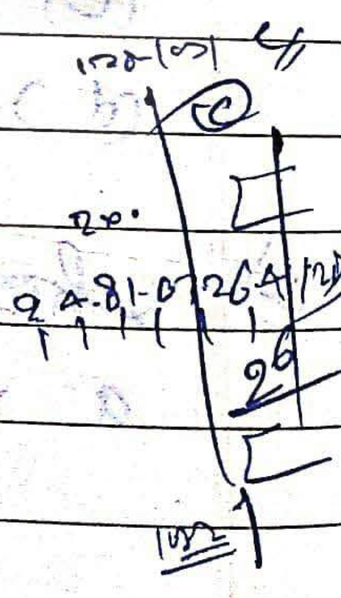
128.75.43.0

128.75.43.16
255.255.255.128

128.75.43.0

128.76.43.16
0.0.0.0

Q.7



Q7 An organisation has class B network and wishes to form subnet for 64 department's. then subnet mask could be.

(a) 255.255.0.0 (b) 255.255.64.0 (c) 255.255.128.0
(d) 255.255.252.0

Sol n

B

255.255.252.0 Ans

Q7 Two Computer's C1 and C2 are configures as follows
C1 has an IP address of 203.197.2.53 and subnet mask of 255.255.128.0, C2 has IP address of 203.197.75.201 and subnet mast of 255.255.192.0
which of the following statement is true
(a) C1 and C2 both assume that they are on the same network
(b) C2 assumes C1 is on the same network but C1 assumes C2 is on different netwrk
(c) C1 assume C2 is on the same

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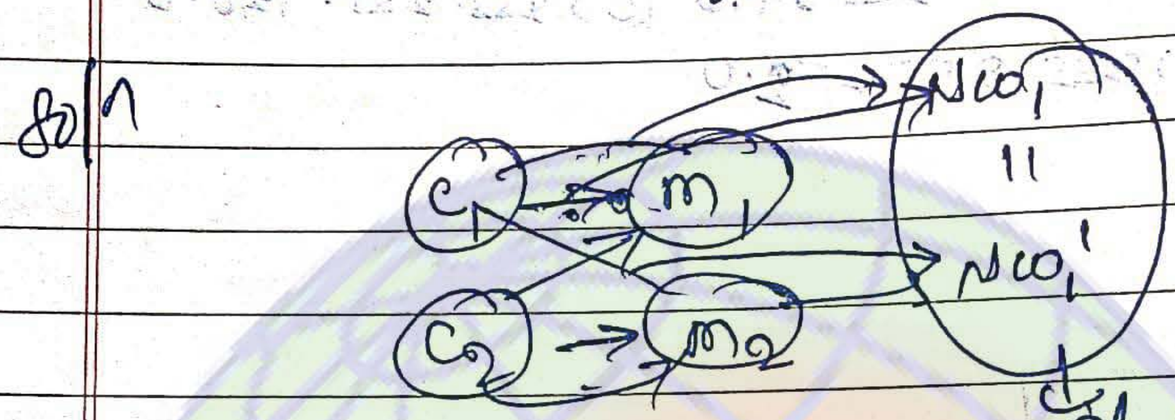
net but C_2 assumes C_1 is on diff network.

(d) C_1 and C_2 both assume that they are on diff network.



If equal then C_1 will understand that both are same

$NW_1 = NW_1'$ → $C_1 \rightarrow C_2$

$NW_2 = NW_2'$ → $C_2 \rightarrow C_1$

Ans c)

Q) Station A, uses 32 byte packets to transmit a messages to station B, using a sliding window protocol. The round trip delay b/w A and B is 80 milliseconds and the bottleneck bandwidth on the path b/w A and B is 128 KBPS, what is the optimal window size that A should use.

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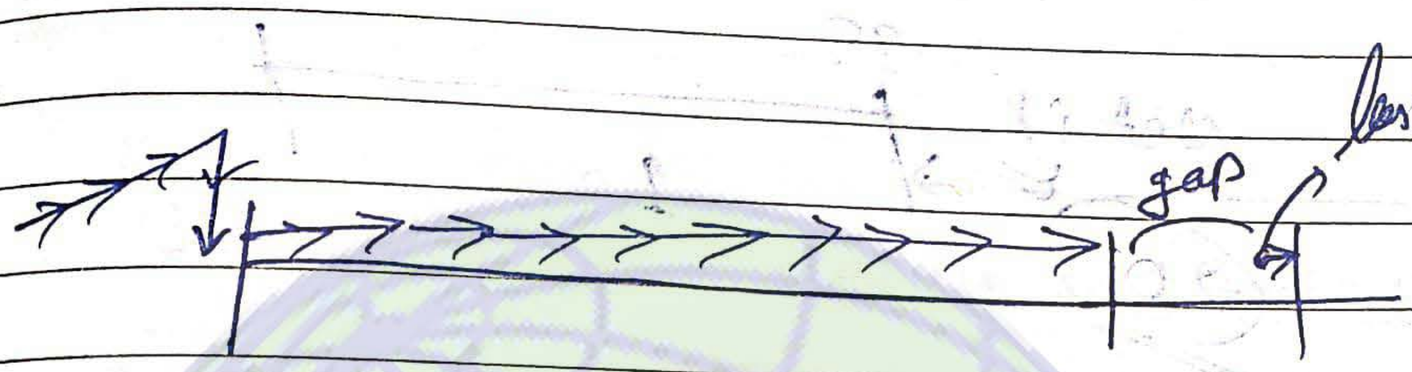
Q7 Suppose the round trip propagation delay for a 10mbps ethernet having 48 jaming signal is 46.4 microseconds. The minimum frame size is.

Sol 7



$$\text{Transmission time} = Pd + \frac{48 + Pd}{B.W}$$

$$\frac{L}{B.W} = 2 \times \frac{Pd + 48}{BW}$$

Q) An internet service provider has the following chunk of CIDR based IP addresses available with it

245.248.128.0/20

Now, this ISP wants to give half of this chunk of addresses to organisation A and a quarter to organisation B, while retaining the remaining with itself.

Which of the following is a valid allocation of addresses to A and B.

(a) 245.248.136.0/21 & 245.248.128.0/22

(b) 245.248.128.0/21 & 245.248.128.0/22

(c) 245.248.132.0/22 & 245.248.132.0/21

(d) 245.248.136.0/24 & 245.248.132.0/21

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80/7

245. 248. 128. 0/20

128 64 32 16 8 4 2 1

2^6

/128 . 0/20

.128. 0/20

32

Net id

12

20

11111111, 11111111, 1111,1111, 11111111

255

2 2 2 2

32

2 2 2 2

2 2

2 2 2

128×2

128

256

256

512

512

244.248.128.

1

7. Network Security:

7.1. Cryptography

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1) Fermat theorem:-

If 'p' is a prime no. and 'a' is a positive integer then $a^p - a$ is an integeral multiple of 'p'.

p = 7

a = 2

$2^7 - 2 / 7 = 0$

$2^7 - 2 / \text{mod } 7 = 2$

modular arithmetic

$$a^p = a \pmod p$$

Remainder

$$\frac{a^p}{a} = \frac{a \pmod p}{a}$$

$$a^{p-1} = 1 \pmod p$$ — eq(i)

$$a^{p-1} - 1 = 0 \pmod p$$

$$9 \overline{)64} (7$$
$$\underline{63}$$
$$1$$

2) Euler totient function: ($\phi(n)$)

$\phi(n) =$

$\phi(9) = 1, 2, 4, 5, 7, 8$

$\phi(9) = 6$ → total no. of count

$\phi(7) = 1, 2, 3, 4, 5, 6$

$\phi(n) = n - 1$ where n is Prime no.

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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- $\phi(56) = \phi(8 \times 7)$

$= \phi(8) \times \phi(7)$

$= 1, 3, 5, 7 \times 1, 2, 3, 4, 5, 6$

$4 \times 6 = 24$ Ans

- $\phi(24) = 1, 5, 7, 11, 13, 17, 19, 23$

$= 8$

$= \phi(8) \times \phi(7)$

4×2

$= 8$

- $\phi(35) = \phi(7) \times \phi(5)$

$= 6 \times 4$

$= 24$

** A/q to euler theorem:-

It state that for every a and n, that (a) are relatively prime to each other

$$a^{\phi(n)} \equiv 1 \pmod{n}$$

(a, n are co prime)

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If n is Prime no.

$\phi = n-1$

$a^{n-1} = 1 \pmod n$

$$a^{p-1} = \mod p$$

(3.) Discrete lograthimic:-

If a and n are relatively Prime, then there is atleast one integer 'm', which satisfy

$$a^m = 1 \pmod n$$

If a and n are relatively Prime

The least positive exponent m, for which a^m is equal to $1 \pmod n$ is defined as:-

~~The order~~

(1) The order or the Price of $(a \bmod n)$

It is also called ~~the~~ length of the Period generated by a.

Q: find the order of $7 \pmod{19}$

Sol:

$a^m = 1 \pmod n$

1 2 4 5 6 8 9

10, 11, 12, 13, 14, 15, 16, 17, 18

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$7^1 \bmod 19 = 7$

$7^2 \bmod 19 = 11$

$7^3 \bmod 19 = 1$ ③

$7^4 \bmod 19 = 7$

$7^5 \bmod 19 = 11$

$7^6 \bmod 19 = 1$

Ans = 3

Q.) Check 3 is a primitive root of 7 or not.

Sol/

$3^1 \bmod 7 = 3$

$3^2 \bmod 7 = 2$

$3^3 \bmod 7 = 6$

$3^4 \bmod 7 = 4$

$3^5 \bmod 7 = 5$

$3^6 \bmod 7 = 1$

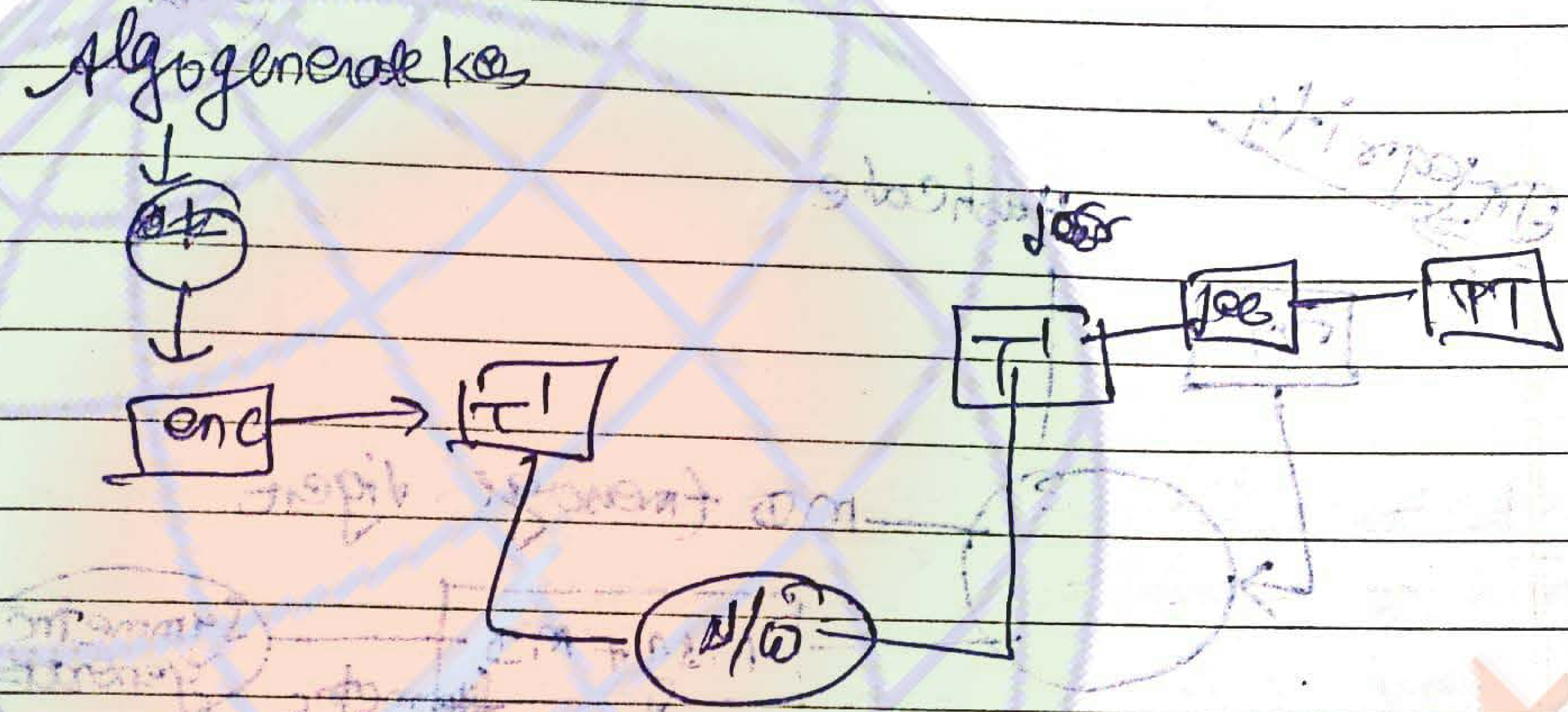
$\phi(7) = 1, 2, 3, 4, 5, 6$

Q.) $3 \pmod 7 \pmod 7 \pmod 7$ ——

Ans $3 \pmod 7$

4.) Diffbi algorithms –

(5) Symmetre –

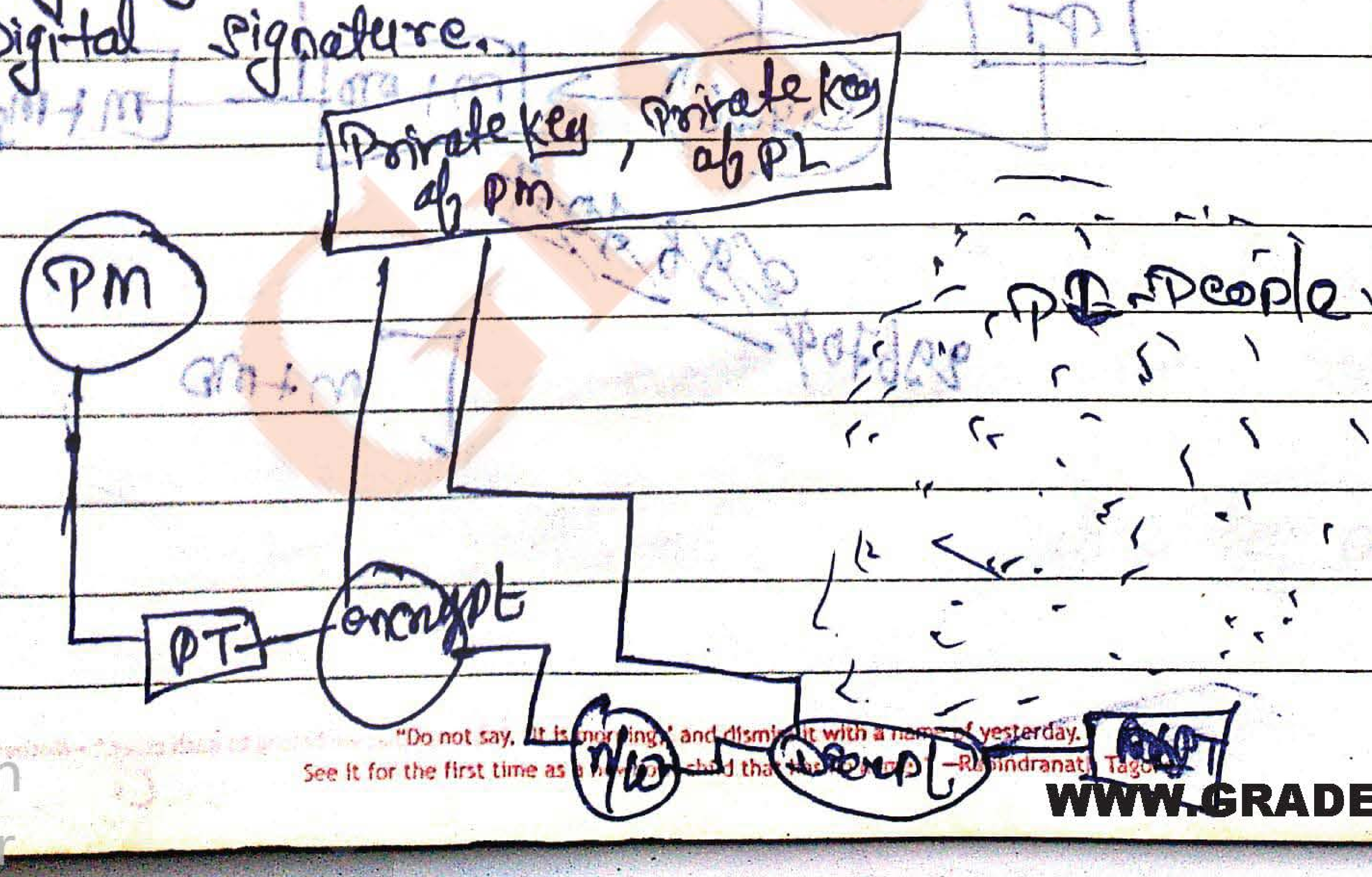


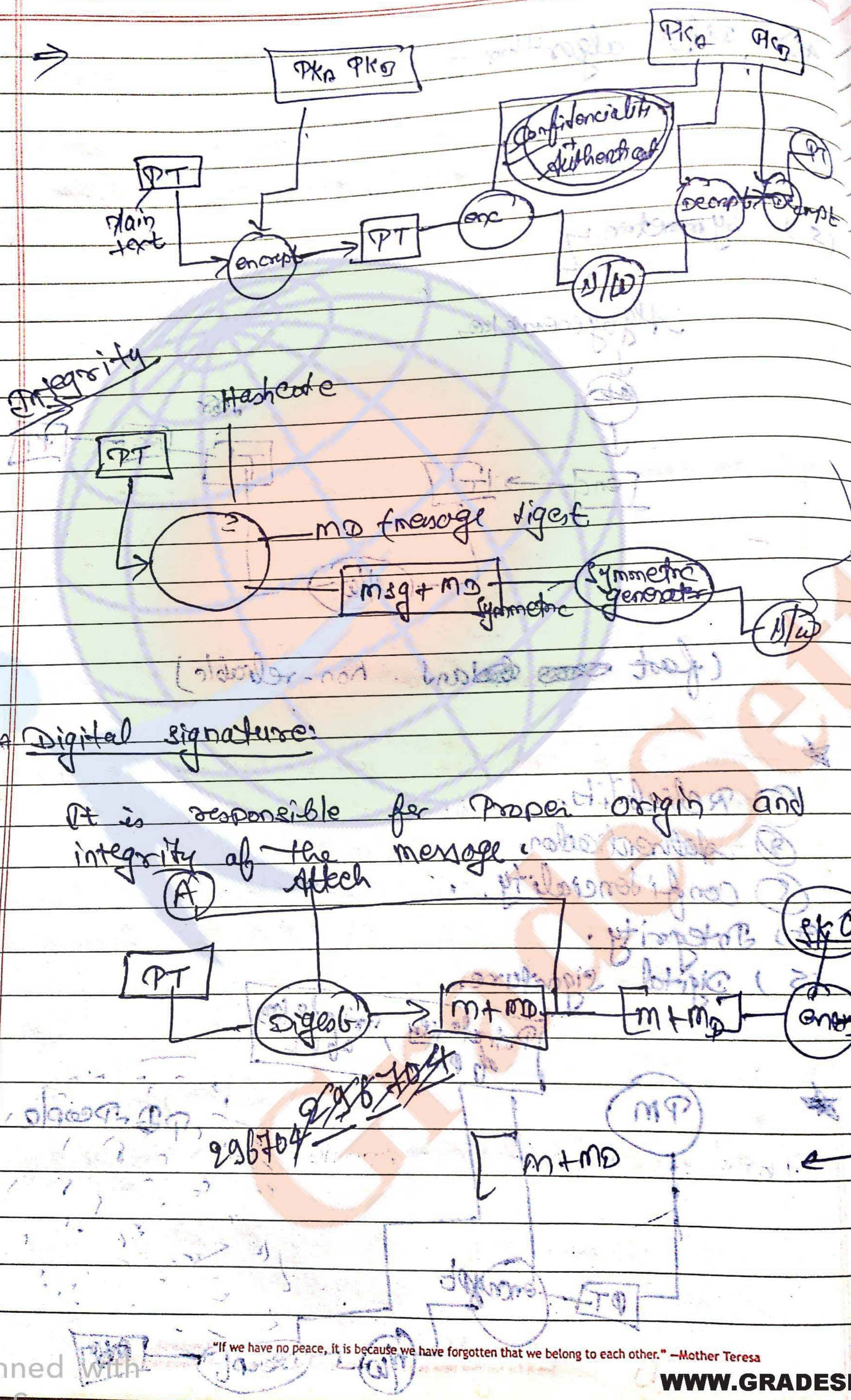
(fast and non-reliable)

★

(1) Reliability.
(2) Authentication.
(3) confidenciality.
(4) Integrity.
(5) Digital signature.

★





* Digital signature:

It is responsible for Proper origin and integrity of the message.

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★ Hashing :-

Hashing produces a message digest, which is a kind of checksum created on the fixed bit.

It is a basically one way incription, and impossible to derive message from digest.

Hashing algorithm's are much faster than any encryption algorithm.

★ Digital certificate :-

A digital certificate is digital file used to cryptographically bind an entities, public key to specific attribute belong's to it's identity.

eg. Driving licence or passport bind a photograph to a personal info about it's folder.

Same as digital certificate bind a public key to the info about it's owner issued by certification authority.

★ RSA algorithm :-

(Ribat shamir adlimen)

This algorithm is based on difficulty of factorising a large number that have two and only two factors.

The system works on a public key and Private key combination.

"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

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Algo:-

Step 1st:-
Two large distinct Prime number 'P and 'Q' must be generated.

Step 2nd:-
Product of these two number's is called as 'n' is a component of the public key. and where

eqn $$d = e^{-1} \bmod \phi(n)$$

should be satisfy.

Step 3rd:-
'e' must be relatively Prime to $\phi(n)$

$$\phi(n) = \phi(p \times q)$$

$$= (p-1) \times (q-1)$$

Step 4:-
We create a description key 'd'

$$d = e^{-1} \pmod{\phi(n)}$$

$$de = (1 \pmod{\phi(n)})$$

'd' is a multiplicative inverse $e \pmod{\phi(n)}$

Note 'd' should always be less than $\phi(n)$

"If we have no peace, it is because we have forgotten that we belong to each other." —Mother Teresa

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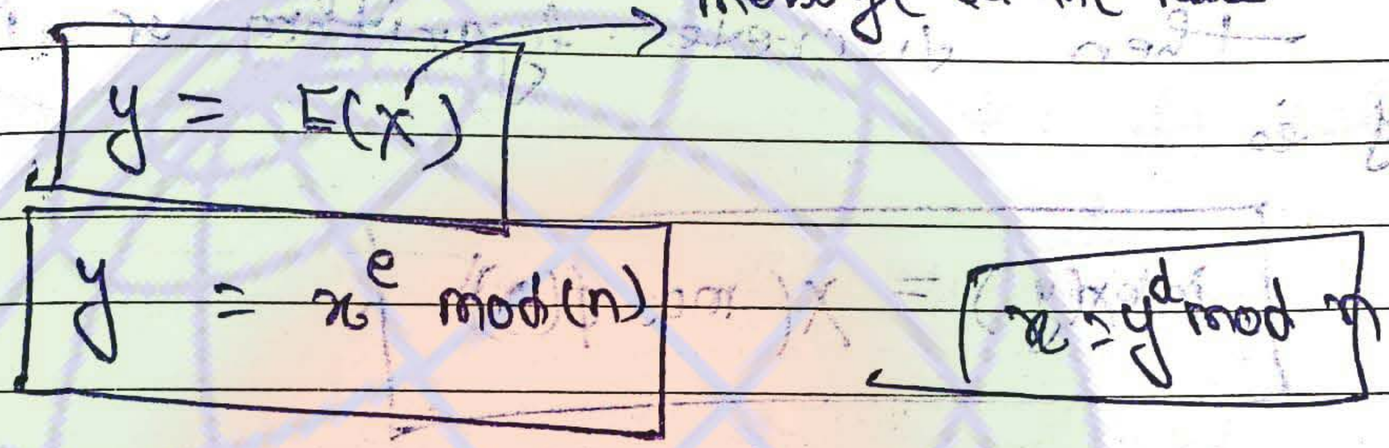
e → ei encrypted ka



Q) If p = 3 and q = 11 calculate x

Sol:

$x = e^{\phi(n)}$

p = 3, q = 11

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★ Diffie Hellman Key exchange Algo.

Any generater G_1 of the group is called primitive root mod P. Suppose G_1 is a primitive root mod P, If G_1^x is equal to y mod P

$$G^x = y \bmod P$$

then discrete logarithm or index of y is

$$\boxed{\text{index}(y) = x \pmod{\phi(P)}}$$

The protocol allows two users exchange their secrete keys over and insecure medium without any prior secrete.

Setup requires:-

(i) Alic and bob agree upon, and make public two numbers.

G_1 and P

where

P is a prime and G_1 is a primitive root mod P.

- Alice chooses a random number a, and computes

$$\boxed{u = g^a \bmod (P)}$$

"If we have no peace, it is because we have forgotten that we belong to each other." —Mother Teresa

and send it to bob.

Bob chooses a random number b and computes

$$v = g^b \bmod(p)$$

and send it to alic.

The key generated by bob is

$$u^b = (g^a \bmod(p))^b$$

$$u^b = g^{a \times b} \bmod(p)$$

and the

$$g^a = (g^{a \cdot b} \bmod(p))^a$$

$$g^{v^a} = g^{b \times a} \bmod(p)$$

1.6 Firewall :-

Trojan and's

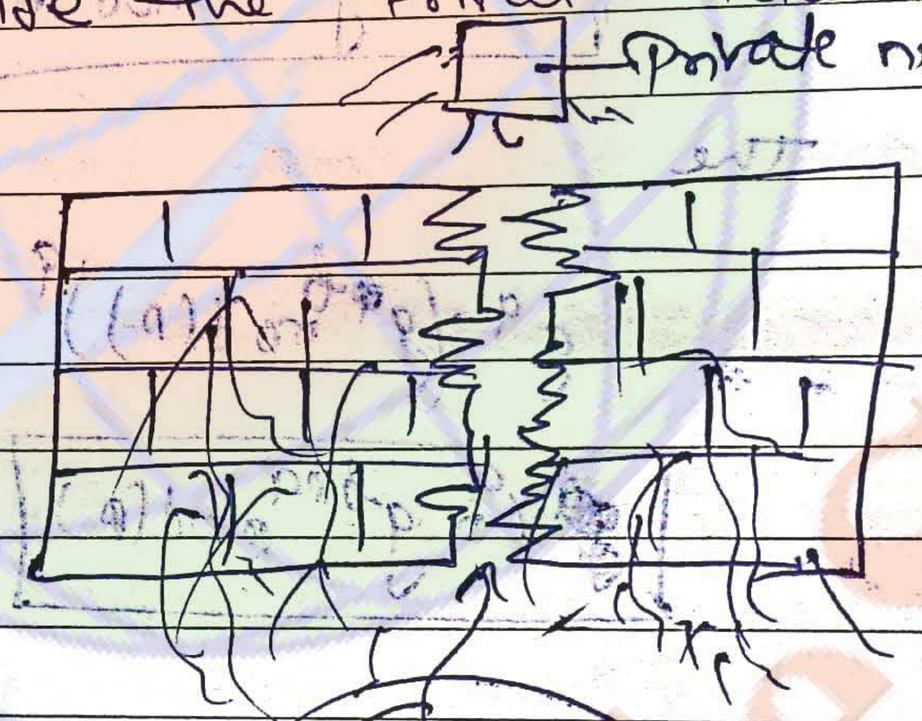
UFD

UBRT

Node

- A firewall is a integrated connection of security measures.
- Design to prevent unauthorized access to a network computer system.

- Firewall policies :-
  - Pre-defined set of rules to protect the isolated system from internet outside the private network.



* Policies actions :-
  - Policies used by firewalls are depending upon some properties of the packets and

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the protocol used.
- Application payload.

* Type of firewall:-

(i) Packet filter,
(ii) Stateful filter's and
(iii) Application layer filter.

(i) Stateless filter
It does not maintain any remembered context or state with resp. to packet. It is processing. Instead it treat each packet attempting to travel through it.

(ii) Stateful:-
It maintenance table for every incoming packet and info within the packet.
(a) ip adres
(b) port adres
(c) and sequence no of the packet of line communication.

* Wifi:-

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Code words

General Studies:-

(I) ~~Coding scheme~~ All error detection and correction method only work below a certain error rate.

- Frame or code word length $n = m + R$
  - m ↓ data
  - R ↓ redundant or check bits

(II) Any data section having valid, we allow any stream of length 'n' i.e. 0 or 1 bit

(III) Not every code word of length 'n' is valid

(IV) No. of valid code words - very small subset of all possible 0 or 1 bit strings of length 'n'.

Error Correcting

(I) All 2^m patterns are legal, not all 2^n patterns are legal.

(II) The basic idea if illegal pattern find the legal pattern closest to it, that might be the original data.

(iii) Give 2 bit string and bitwise xor gives you no. of bits that are different.

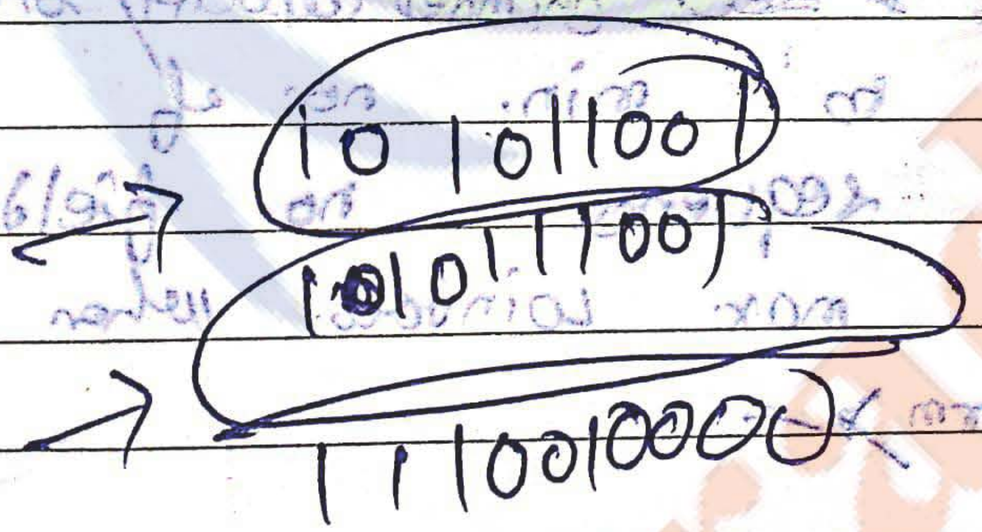
(iv) If two codewords are hamming distance 'd' apart it will take 'd' one bit error to convert one into other.

* Imp Point :-

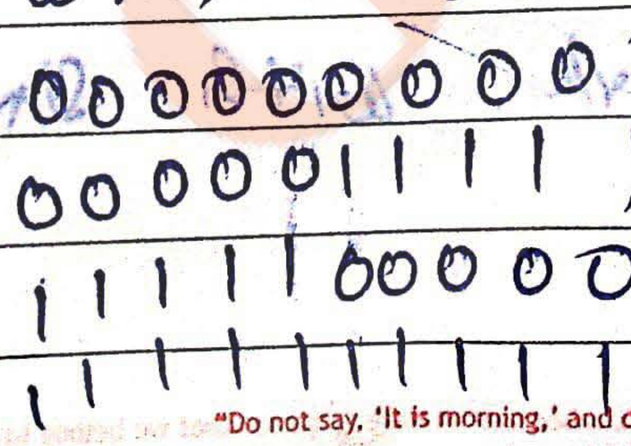
(a) to detect (but not correct) upto d-errors per length n, you need a coding scheme where codewords are atleast d+1, apart in hamming distance.

Then,
'd' errors can't change 1 into another legal codes so we know there has been a error.

So, To correct 'd' errors need codewords 2d+1 apart. then, even with d-errors bits string will be d-away from original. and d+1 away from the nearest legal code.



a) 4 valid code words, 10 bits



"Do not say, 'It is morning,' and dismiss it with a name of yesterday. See it for the first time as a newborn child that has no name." —Rabindranath Tagore

difference d = 5

min. distance – 5,

Error detect :- > 4

correct :- 2d+1

Q) n-station, each S

what is the prob that only

on station

~~(?) distance b/w~~

Q) msg :=> 11001001 generator polynomial x^3+1

what message should be transmitted

8
7. 2t.1 (O.T)

so/9 11001001

Q) Distance b/w two station m and n,

(m) ———— (n)
L

frams are K-bit's long, ~~Propagation~~ Processing delay per

kilo meter in ~~sec~~ t sec. channel capacity/ bit rate/ bandwidth = r ~~byte~~ bits/sec. to min. no. of bit's

requires for sequence no. field's in a frame with max window when a sliding window form →

|so/9|

Q) Consider a network with six router R_1 to R_6.

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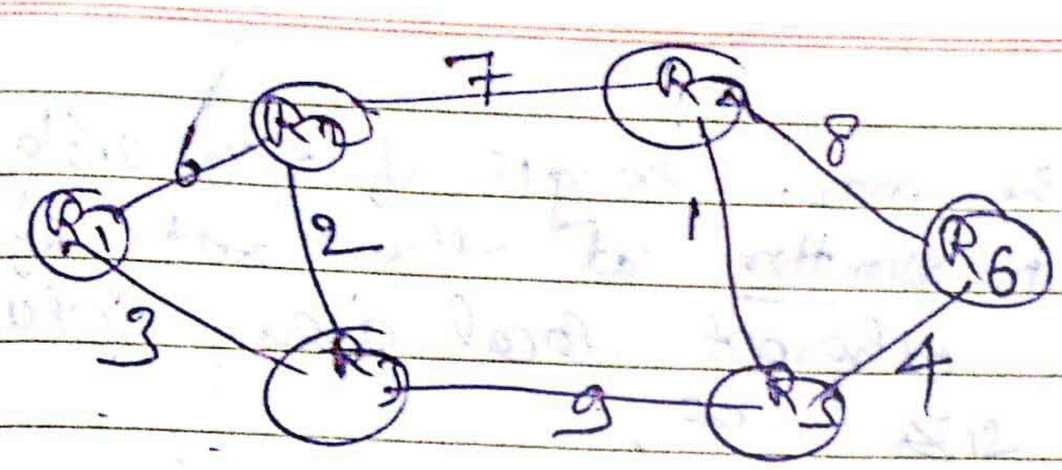
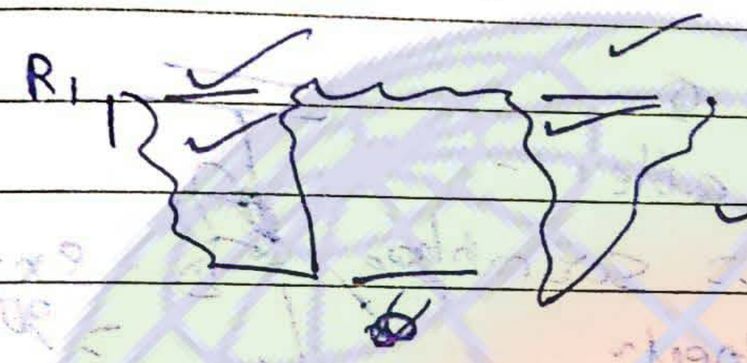
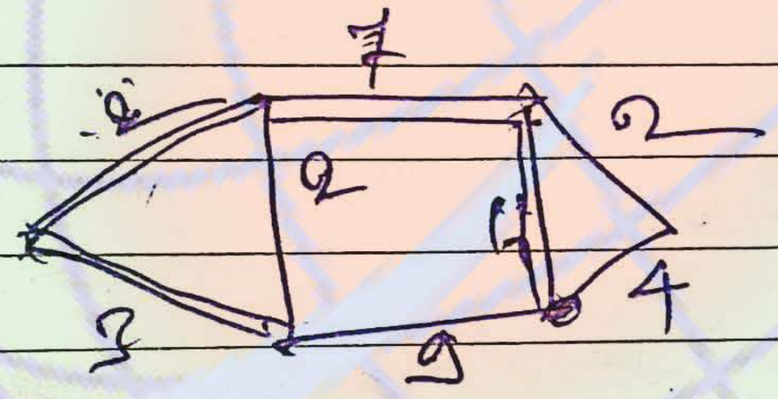




weights of all unused link change to 2



how may link now remain unused

a) ~~which of the~~

SOLUTION →

10 → 4

10^4

3.49