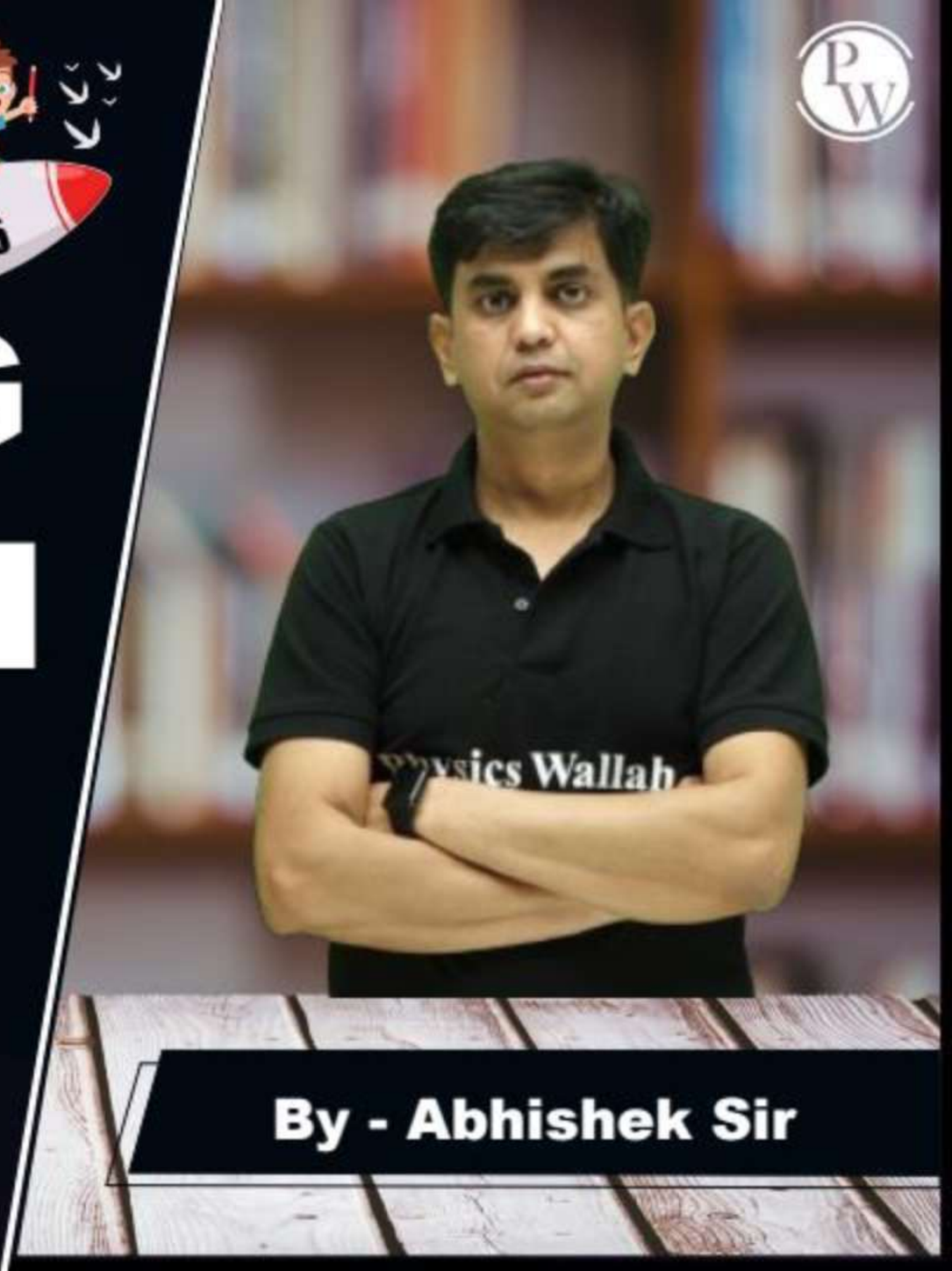
CS & IT ENGINEERING

Computer Network

Transport Layer

Lecture No. - 04



By - Abhishek Sir

Recap of Previous Lecture

Topic TCP Header

Topic TCP Sequence Number

Topic TCP ACK Number

Topics to be Covered

- Topic: Maximum Segment Lifetime (MSL)
- Topic: TCP Connection Establishment
- Topic: TCP Connection Close

ABOUT ME

Hello, I'm Abhishek

- GATE CS AIR - 96
- M.Tech (CS) - IIT Kharagpur
- 12 years of GATE CS teaching experience

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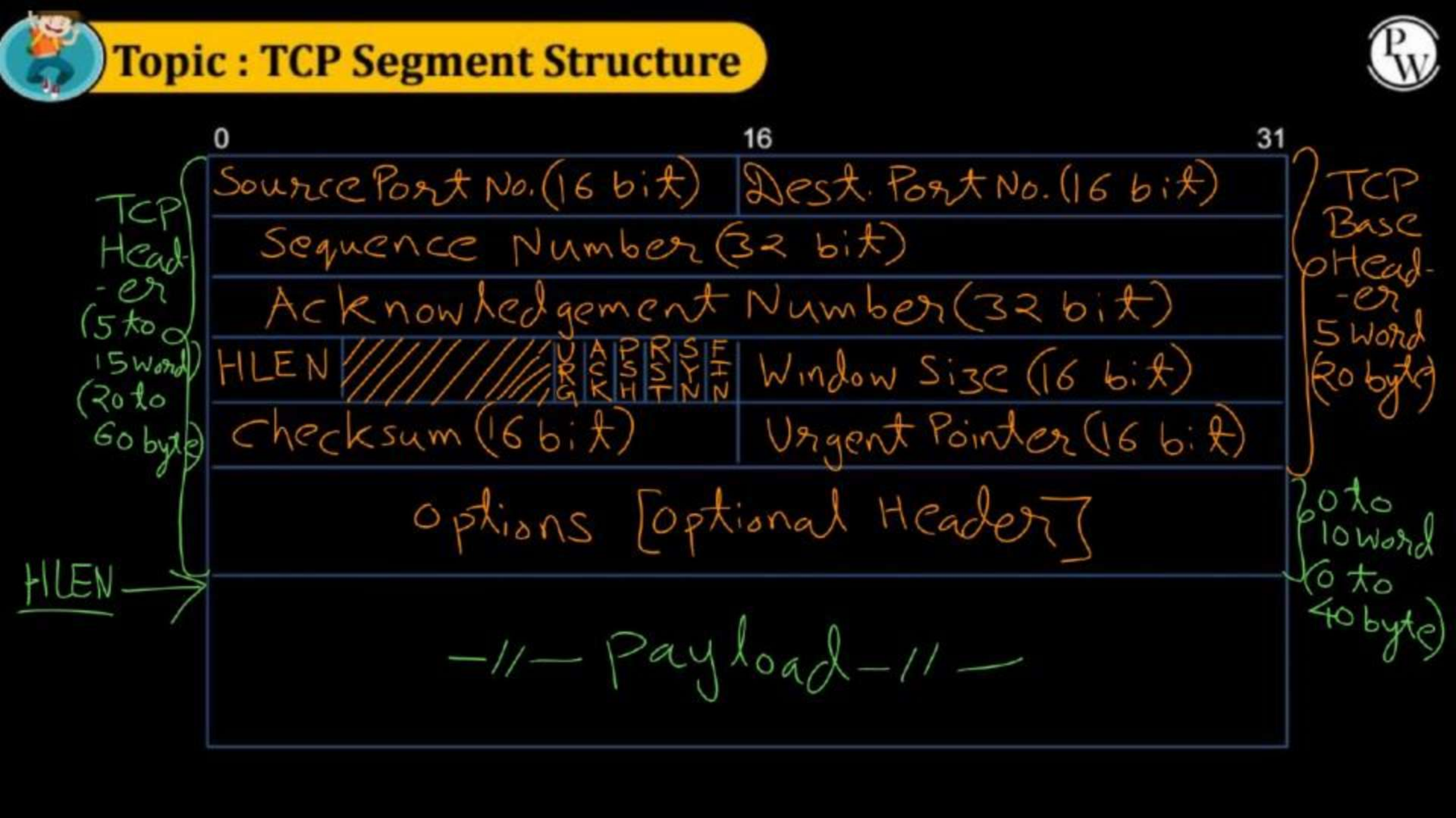
Topic : TCP Segment Structure



#Q. Consider a TCP connection in a state where there are no outstanding ACKs. The sender sends two segments back to back. The sequence numbers of the first and second segments are 230 and 290 respectively. The first segment was lost, but the second segment was received correctly by the receiver. Let X be the amount of data carried in the first segment (in bytes), and Y be the ACK number sent by the receiver. The values of X and Y (in that order) are :

[GATE-2007]

(A) 60 and 290

(B) 230 and 291

(C) 60 and 231

(D) 60 and 230

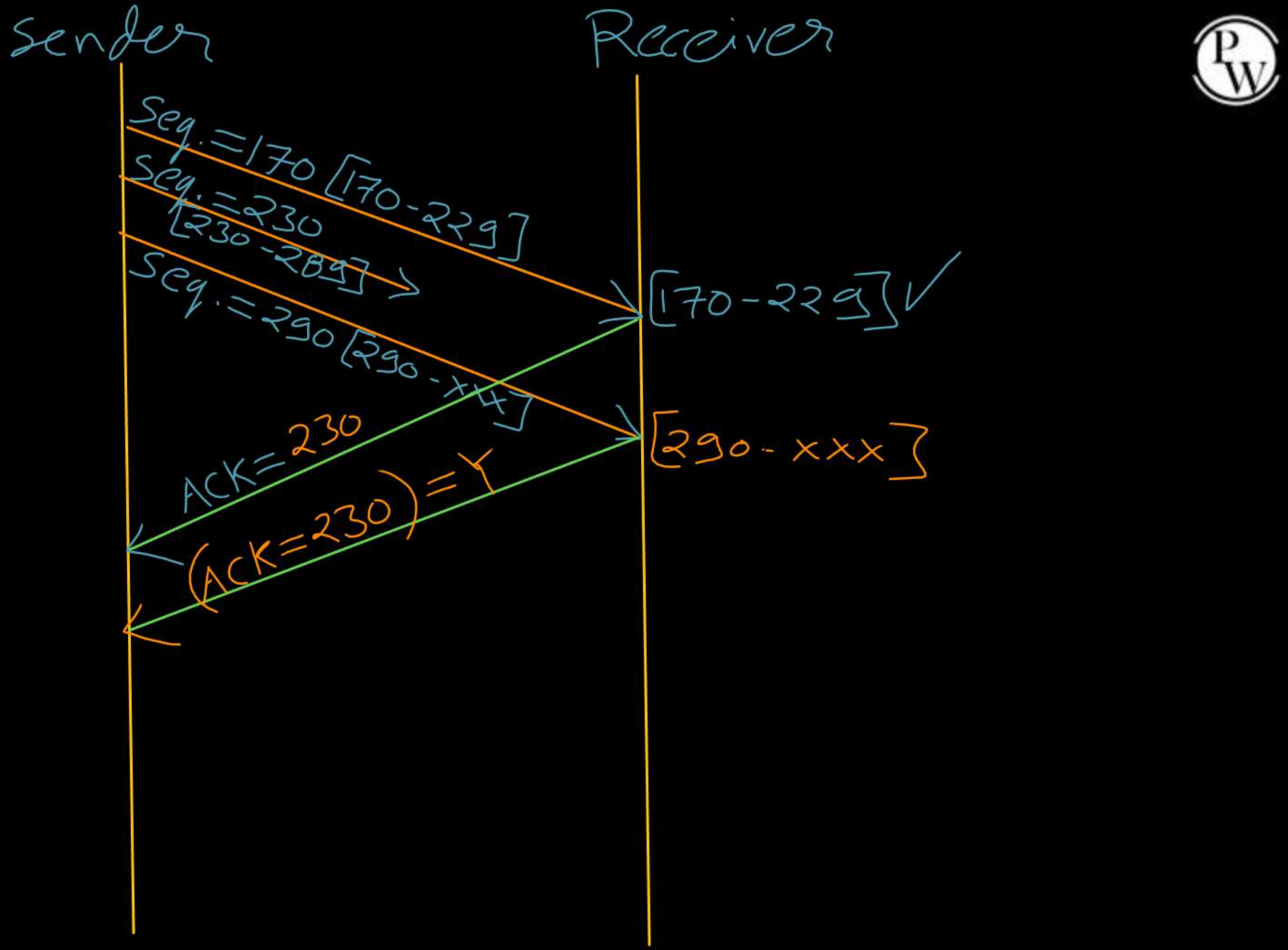
Ans: D

$X = 60$

seq = 290

Receiver send

Ack No. = Y = 230


Sender
Receiver
Seq. = 170 [170 - 229]
Seq. = 230 [230 - 289]
Seq. = 290 [290 - xxx]
[170 - 229] ✓
[290 - xxx]
ACK = 230
(ACK = 230) = Y

Topic : Maximum Segment Lifetime

=> Maximum Segment Lifetime (MSL)

=> Wrap-around time = MSL

=> Duration for a TCP segment can exist in an inter-network system

Suppose size of sequence number field is k bits in TCP header, (generally k = 32 bits)

$$\text{MSL} = \frac{2^k \text{ Bytes}}{\text{Bandwidth}} = \frac{2^{32} \text{ Bytes}}{\text{Bandwidth}}$$

Seq. No. = 300 ..... $(2^{32}-1), 0, 1, 2, \ldots\ldots 299, 300$

Total = 2^{32} numbers

2^{32} bytes = 4GB

Wrap-around Time = $\frac{2^{32}\text{ Bytes}}{\text{Bandwidth}}$

[min^m time]

Seq. = 300 .... 399, 400 ..... 499 ..... 150 300 249

segment$_1$ segment$_2$ segment$_n$

Seq. = 300 Seq. = 400 Seq. = 150

Max^m segment Lifetime = Wrap-around time

#Q. Consider a long-lived TCP session with an end-to-end bandwidth of 1 Gbps (= 10^9 bits-per-second). The session starts with a sequence number of 1234. The minimum time (in seconds, rounded to the closest integer) before this sequence number can be used again is _____. [GATE-2018]

IIT-G

Seq. No. = 1234, ... $(2^{32}-1)$, 0, 1, ... 1233, 1234

$$\text{Wrap-around time} = \frac{2^{32}\text{ bytes}}{\text{Bandwidth}}$$

$$= \frac{2^{32} * 8\text{ bits}}{1\text{Gbps}} = \frac{2^{35}\text{ bits}}{10^9\text{ bits/sec}} = 34.35\text{ sec}$$

≈ 34 sec

Ans = 34

$$MSL\ (Wrap\ around\ time) = \frac{2^k\ bytes}{Bandwidth}$$

[k = No. of bits in seq. no. field]

$$[2^k\ bytes] = [MSL * Bandwidth]$$

#Q. Consider the data transfer using TCP over a 1 Gbps link. Assuming that the maximum segment lifetime (MSL) is set to 60 seconds, the minimum number of bits required for the sequence number field of the TCP header, to prevent the sequence number space from wrapping around during the MSL is _____.

[GATE-2022]
IIT-KGP

Bandwidth = 1 Gbps = 10^9 bits per sec

MSL = 60 sec

No. of bytes can be transmitted in one MSL

= MSL * Bandwidth = 60 sec * 10^9 bits/sec

= $6 * 10^{10}$ bits = $\left(\frac{6}{8}\right) * 10^{10}$ bytes

Minm no. of bits required for sequence no. field

= $\lceil \log_2 (\text{No. of Bytes can be transmitted in one MSL}) \rceil$ bits

= $\lceil \log_2 (6 * 10^{10}/8) \rceil$ bits = $\lceil 32.80 \rceil$ bits = 33 bits

Ans = 33

#Q. Suppose you are asked to design a new reliable byte-stream transport protocol like TCP. This protocol, named my TCP, runs over a 100 Mbps network with a Round Trip Time of 150 milliseconds and a maximum segment lifetime of 2 minutes. Which of the following is/are valid lengths of the Sequence Number field in the my TCP header?

[GATE-2023]

IIT-K
H.W.

(A) 30 bits

(B) 32 bits

(C) 34 bits

(D) 36 bits

Topic : Header Length

→ Header Length [HLEN]

→ HLEN field is 4 bits long

→ Size of header in words
[Word of 4 bytes]

Topic : Header Length

→ Minimum Header Size = 5 Words (20 Bytes) (Base Header)

$5 <= HLEN <= 15$

→ Maximum Header Size = 15 Words (60 Bytes)

Topic : TCP Operation

Three phases of TCP operation :

1. Connection establishment
   → 3-way handshake process that establishes a connection
2. Data transfer
3. Connection termination
   → 4-way handshake process that closes the connection

Topic : TCP Connection Establishment

→ Connection establishment between TCP client and TCP server

→ 3-way handshake process

→ Always TCP client initiate the connection request to TCP server

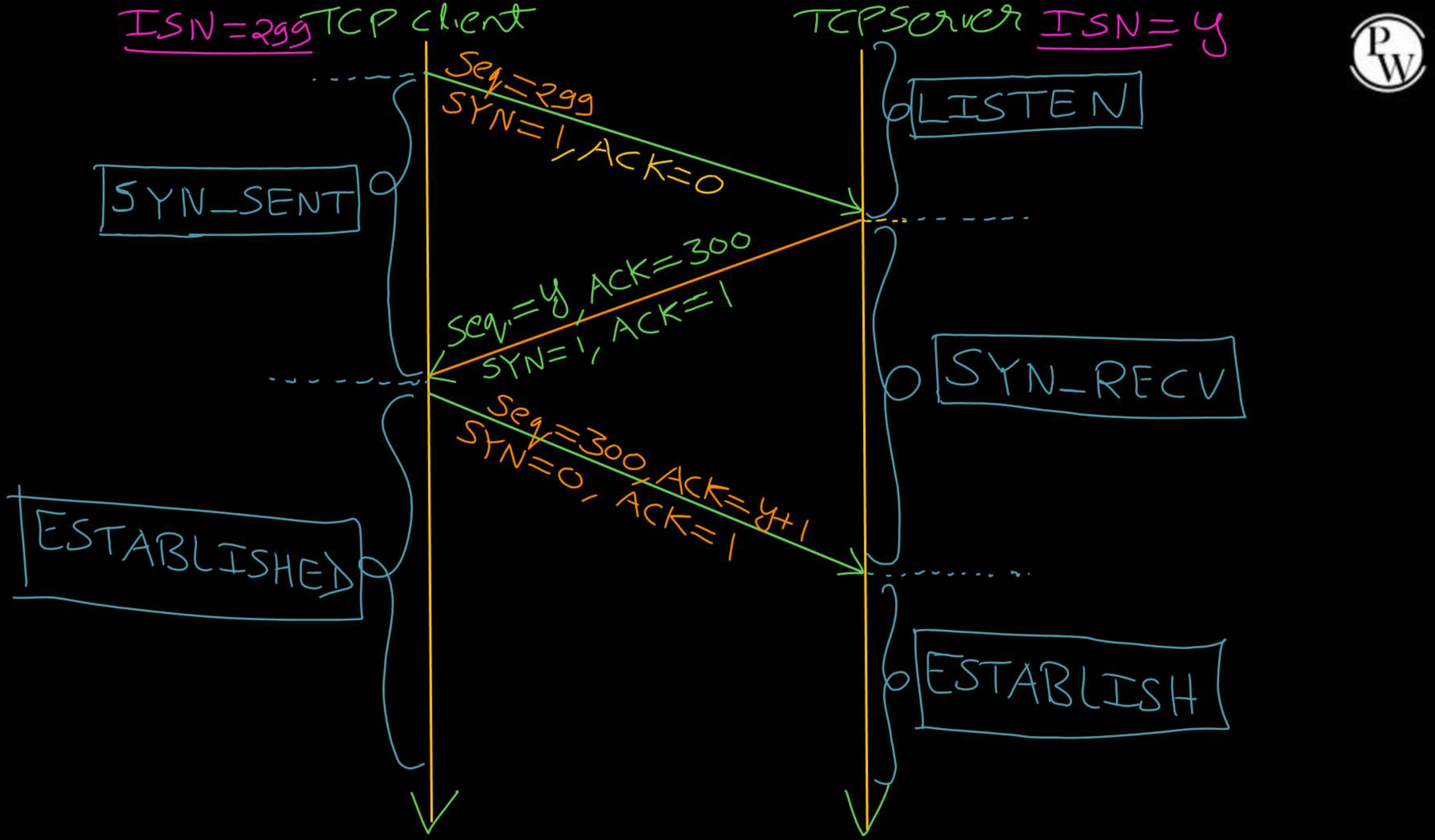
→ Initial Sequence Number : if SYN flag is on
[both TCP client and server randomly chooses their initial sequence number, to prevent from some kind of attacks]

→ SYN packet consume one sequence number

→ No any payload (user data) in SYN packet

6 flag bits :-

1) URG = Urgent flag
2) ACK = Ack flag
3) PSH = Push flag
4) RST = Reset flag
5) SYN = Synchronize flag
6) FIN = Finish flag


ISN=299
TCP client
TCP Server
ISN=y
Seq=299
SYN=1, ACK=0
LISTEN
SYN_SENT
seq=y, ACK=300
SYN=1, ACK=1
SYN_RECV
Seq=300, ACK=y+1
SYN=0, ACK=1
ESTABLISHED
ESTABLISH

[MSQ]

#Q. TCP client P successfully establishes a connection to TCP server Q. Let N_P denotes the sequence number in the SYN sent from P to Q. Let N_Q denote the ACK number in the SYN+ACK from Q to P. Which of the following statements is/are correct?

[GATE-2024, Set-1, 1-Mark]

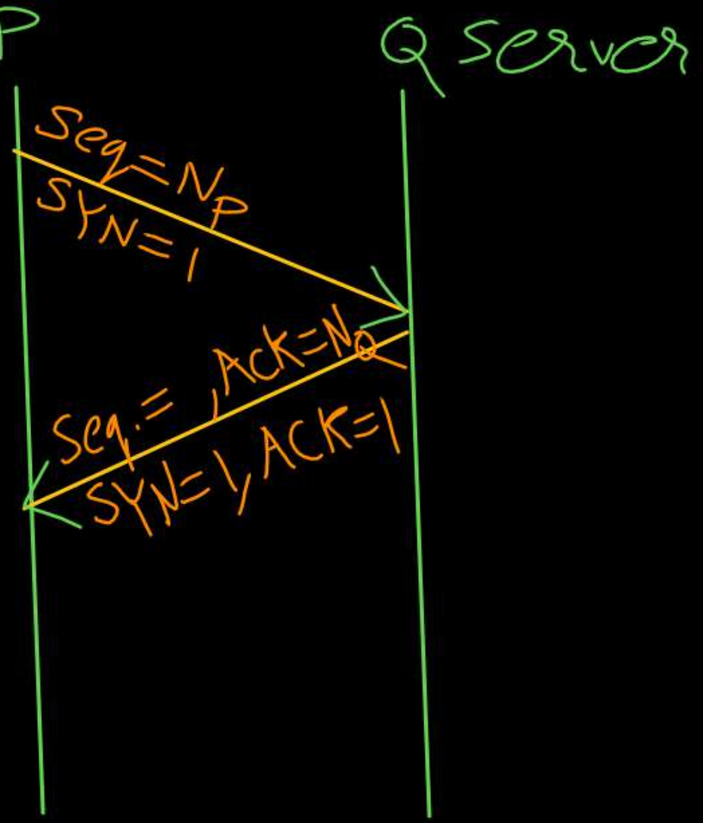
IISC

(A) The sequence number N_P is always 0 for a new connection. FALSE

(B) The ACK number N_Q is equal to $N_P + 1$ TRUE

(C) The sequence number N_P is chosen randomly by P TRUE

(D) The ACK number N_Q is equal to N_P FALSE



$N_Q = N_P + 1$

Ans: B & C

#Q. Which of the following statements are TRUE for 'three way handshake' for TCP connection establishment ?

(S1) Loss of SYN + ACK from the server will not establish a connection

(S2) Loss of ACK from the client cannot establish the connection

(S3) The server moves LISTEN → SYN_RCVD → SYN_SENT → ESTABLISHED in the state machine on no packet loss

(S4) The server moves LISTEN → SYN_RCVD → ESTABLISHED in the state machine on no packet loss.

[GATE-2008]

(A) S2 and S3 only

(B) S1 and S4 only

(C) S1 and S3 only

(D) S2 and S4 only

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H.W.

2 mins Summary

Topic Maximum Segment Lifetime

Topic TCP Connection Establishment

Topic ~~TCP Connection Close~~

THANK - YOU